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DIRECT DEMONSTRATION OF PERFORATED ULCERS[1]

by

J. Frimann-Dahl

The roentgen examination of perforated ulcer of the stomach or duodenum is generally undertaken to show a pneumo-peritoneum. Many investigators use this method systematically to diagnose that lesion. In other clinics it is perhaps only used occasionally and in doubtful cases. The clinical diagnosis of a perforated ulcer is generally certain. According to PETRÉN the roentgen examination is definitely helpful in at least 10 % of the cases. The failure of the clinical examination should therefore justify the performance of a roentgen examination. On the other hand it is a well known fact that this investigation also is not always definite. It is possible to demonstrate a pneumo-peritoneum in 70—90 % of the cases depending upon the exactness of the examination. These patients must be examined as quickly as possible, and the cooperation between the roentgenologist and the surgeon must be the best possible.

Films are made in different postures, in upright position and in lateral recumbency with horizontal direction of the rays, and supine both with horizontal and vertical direction of the rays. If only little free gas is present, films must be made with the tube centered exactly at the level of the gas or it will easily be overlooked. Fluoroscopy may facilitate the demonstration of the gas.

In addition to pneumo-peritoneum there are many other signs of a perforation in the intestinal tract. For instance free fluid in the peritoneal cavity, paretic intestinal coils with horizontal fluid levels, scoliosis of the spine and contraction of the flanks and so on.

In order to demonstrate a perforated ulcer directly, small amounts of barium by mouth have been tried. Sometimes a duodenal ulcer may be diagnosed in that way and a simultaneous pneumo-peritoneum proves a perforation. However, this method is of doubtful value and should be

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used only in dubious cases. Even if a penetration of barium into the peritoneal cavity is without any danger to the patient, the method has the drawback that the pictures are very difficult to interpret. At the same time the barium suspension will descend in the small intestine and cover a great part of the abdominal field, thus making the contrast in the peritoneal cavity very hard to recognize.

However, another contrast medium is available; that is the gas (air) in the stomach and duodenum which has descended to the fornix during the intake of food. Occasionally a deformation of this gas bubble in the fornix (fundus) is that striking on plain films of the abdomen — or even on chest films — that a diagnosis of cancer in this part of the stomach can be made almost with certainty. (Fig. 1.) These findings are well known to most radiologists (PILLMORE).

The question now arises whether the gas in the stomach also could be used to diagnose small ulcers in cases where the use of barium contrast is not convenient. We will try to express our opinion on this subject in the following. In cases of perforated ulcers the stomach is not always empty. Experiences have, on the contrary, proved that it more often is somewhat distended by gas (KLASON). When gas in abundance is present this finding points, in our opinion, towards a stenosis in the pylorus and the probability that the ulcer is located in that region.

The direct demonstration of the »niche» by means of gas in the stomach has previously been mentioned in a few cases (FRIMANN-DAHL). With this exception, as far as can be seen, it has not been previously described.

One may object that this finding is of subordinate importance compared with the demonstration of pneumo-peritoneum. It may in different ways, however, be of decisive value. First we must realize that a pneumoperitoneum does not always mean a perforated stomach ulcer. The roentgen finding of free gas in the peritoneal cavity is a symptom indicative of various lesions in the abdomen. A perforation may be located anywhere in the intestinal tract (SKARBY). To the surgeon it would evidently be a great advantage if he at the same time was informed, not only about a present perforation but also, when possible, about where the ulcer is located.

When the case history points towards dyspepsia, one will consequently suggest a perforation of the stomach or the duodenum. Even if so is the case it should be of some importance to the surgeon to get a hint where to make his incision, whether for an operation on the lesser curvature or on the region of the pylorus.

A direct demonstration of the perforated ulcer is possible only in certain cases. In our material consisting of 268 cases of perforated ulcers examined in the last 10 years, the roentgenograms show a »niche» in 22 cases: in 8 %. Not all of these were diagnosed during the preoperative

Fig. 1. Plain film of the abdomen shows defect in fornix of the stomach due to cancer infiltration.

Fig. 2. Perforated duodenal ulcer shown directly in gas-filled bulb.

examination, but scrutinizing the films closer small air bubbles could be seen corresponding to the crater of the ulcer found at operation. Simultaneously a pneumo-peritoneum was found.

The ulcers most readily seen on the films were those situated on the lesser curvature of the corpus at or above the incisure or in the duodenal bulb (Fig. 2). It is well known that perforated ulcers are often located in the juxta-pyloric region. However, experience has taught that just in this area the ulcers are difficult to demonstrate on the films. It should be kept in mind that these patients have not been examined with any sort of compression or similar manipulations. It is more or less by chance whether the ulcers are visible or not.

The best positioning for visualization of these ulcers is the left lateral recumbency. Then also the pneumo-peritoneum appears distinctly, because the gas moves towards the pyloric region and gives the greatest chance for a penetration into the abdominal cavity in above mentioned position. In other cases the gas may fill the »niche» and be fairly well exhibited in ordinary upright or even in supine position (Fig. 3). Indications for a systematic examination of the stomach to search the perforating ulcers seem to be reasonable. Probably then even more gas-filled ulcers could be demonstrated than in our material.

The stomach is, as mentioned, often distended by gas in cases of pyloric stenosis. If a direct diagnosis is impossible, the roentgenograms may show that there are no ulcers in certain parts of the viscus (Fig. 4).

The material also includes cases of a deformity of the duodenal bulb,

Fig. 3. A. Perforated ulcer. Gas-filled crater on the lesser curvature. Patient supine. Fluid in the pelvis. — B. Simultaneously pneumo-peritoneum was found. Horizontal direction of the rays.

without any definite crater. When in these cases a pneumoperitoneum is present, it seems, after all, rather probable that the bulb is the seat of the perforation.

The diagnosis by means of the gas in the stomach can also be made in cases of penetrating ulcers. When a great ulceration is visible on the lesser curvature but there is no pneumo-peritoneum, the diagnosis will be close at hand. It will however take us too far to enter into details on that question here.

In other cases the plain films may show a deformity of the duodenal bulb, eventually also an ulcer, but the peritoneal irritation is of another origin (Fig. 5). This happened in one of our cases which showed signs of a deformed bulb and a regional peritonitis. The operation revealed correctly a duodenal ulcer, but simultaneously a perforated appendix was found. Another case showed a local gas-filling of the duodenum, but no free gas in the peritoneal cavity. The patient, having very definite clinical signs of a perforation, was operated. A small ulcer was found on the anterior wall of the bulb, and some pus surrounded the duodenum which was injected and somewhat distended by gas.

Finally it may be objected that even if a »niche» is demonstrated, this will not necessarily always represent the seat of the perforation. That is certainly right. One of our cases showed a large niche on the lesser curvature and pneumo-peritoneum. At the operation, however, a second ulcer near the pylorus was disclosed and correspondingly a small penetration of the wall. This »niche» was, however, not visible on the films.

All reservations taken into consideration, the findings are interesting and may occasionally give the roentgenologist a relatively easy diagnosis when he is aware of these possibilities.

Fig. 4. Gas-filled crater of the bulb. No signs of ulcerations in the stomach.

Fig. 5. Duodenal ulcer. Deformity of the bulb and gas-filled »niche».

SUMMARY

On the basis of a material of 268 cases of perforated ulcers of stomach and duodenum it is shown that the »niche» could be seen in 8 % of the cases without any contrast medium. The gas in the stomach filled the crater which was fairly well exhibited on the films. These findings have been previously mentioned by the author, but are otherwise not earlier described.

ZUSAMMENFASSUNG

Ein Material von 268 perforierten Magen- und Duodenalgeschwüren zeigte dass eine Nische in 8 % der Fälle ohne Kontrastmittel diagnostiziert werden kann. Das Gas in dem Magen füllt die »Nische», die dabei auf den Filmen sichtbar wird. Diese Befunde sind früher von dem Verfasser besprochen, aber sonst nicht beschrieben.

RÉSUMÉ

Sur un matériel de 268 cas d'ulcères perforées d'estomac il a été possible de diagnostiquer, sans substance opaque, une »niche» dans 8 % des cas. Le gaz dans l'estomac remplit la niche qui est ainsi nettement visible sur les films. Ce fait a été signalé auparavant par l'auteur, mais il n'en existe autrement aucune description.

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FROM THE ROENTGEN DEPARTMENT OF CARLANDERSKA SJUKHEMMET, GOTHENBURG, SWEDEN (HEAD: DR. H. ODQVIST)

THE MOVEMENT OF THE MITRAL RING IN CASES OF PATHOLOGIC CHANGES IN THE LEFT VENTRICLE ESPECIALLY WITHIN THE POSTERIOR PAPILLARY MUSCLES[1]

by

Henning Odqvist

When comparing the movement curves of intracardial calcifications discovered by the various investigators — whether these curves are shown by cineroentgenography or by any other means such as, for instance, »die gezielte Herzaufnahmen» according to HUBACHER — it is an absolute sine qua non that, in the first instance, the calcifications have precisely the *same topographical position*. Secondly it is necessary that the *heart muscles* are at the same time either completely sound or, if there should be any pathologic changes within them, that these should be identically of the same nature and have precisely the same localization. It would seem, however, difficult, not to say impossible, to determine this latter condition by purely clinical means. Furthermore, the patients ought to have been examined in the same position and with a similar direction of the rays.

In 1945 I published in Acta Radiologica a description of the movement curve of a horseshoe-shaped calcification in the annulus fibrosus mitralis. This was based upon a cineroentgenogram which was made in 1944 and demonstrated to the Swedish Association for Medical Radiology in 1945. This cinemetrographic film was taken of the patient in the sitting posture, partly quite frontally and partly in the first oblique projection.

B. HOLMGREN has also taken a cineroentgenographic film of an intracardial calcification which was published in Acta Radiologica in 1946 under the title: »The movement of mitro-aortic ring recorded simultaneously by cineroentgenography and electrocardiography.»

When HOLMGREN talks about »mitro-aortic ring» he clearly expresses his uncertainty about the localization of the calcification in his case. Bu

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Fig. 1.

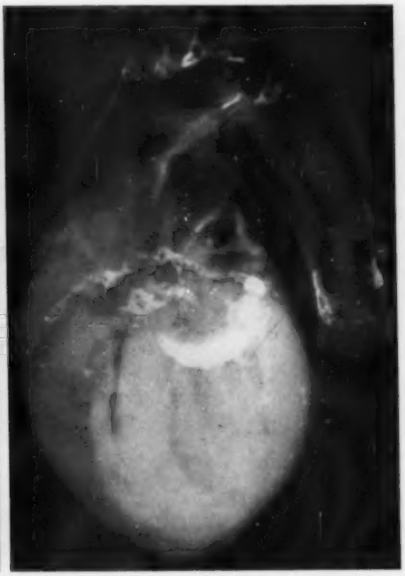

Fig. 2.

Figs. 1—3. Roentgenograms of the removed heart in the three classical projections. In addition to the horseshoe-shaped calcification in the annulus fibrosis mitralis there is also calcification in the root of the anterior mitral valve and in the aortic valve. Wide-spread coronary sclerosis.

the movement of the root of the aorta and the ostium mitrale need not necessarily be identically alike. I would only point out here the presystolic movement of the mitral ring in a cephalic direction which is in all probability caused by contraction of the left auricle. This movement can scarcely influence the movement of the root of the aorta to any degree worth mentioning. HOLMGREN describes the movement in an intracardial calcification which he thinks lies in the mitral ring, *rectilinearly*.

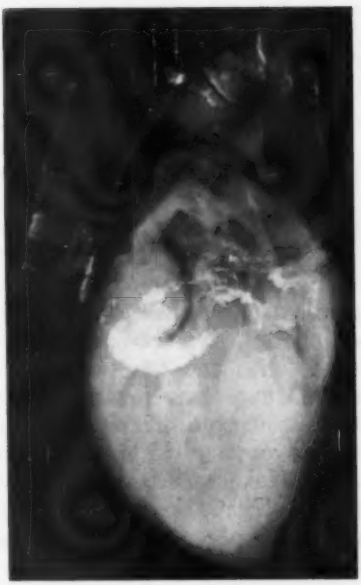

Fig. 3.

Fig. 4. Stenosis valv. aortae.

Fig. 5. Special picture of the aortic root in frontal aspect. The calcification in the valves is projected on the left half of the vertebral column.

The course of the movement observed in my case was *triangular*. As HOLMGREN is of the opinion that this discrepancy in the movement might be due to the fact that the calcification in my case lay in a mitral valve, I would point out that a calcification of stated size and of horseshoe shape in appearance, the topographical position of which has been described, can hardly be thought to lie in a valve. For that matter the recently made section in my case has verified my roentgen diagnosis: calcification in the annulus fibrosus mitralis (see figs. 1—3 and the pathoanatomic report).

The accompanying roentgenogram does not show the position of the calcification in HOLMGREN's case.

Practically speaking all calcifications in the mitral ring, when irradiated frontally, are topographically manifest on the left side of the vertebral column if there is no great dislocation of the heart or no curvature of the spine. On the other hand, calcification of the aortic root, by screen examination frontally, is usually manifest on the left half of the vertebral column and therefore cannot be so easily detected by the eye especially if the patient is fat and one does not use *a sufficiently powerful rays*. If the patient is then rotated somewhat to the left it appears to the left of the vertebral column. When examining in the second oblique diameter it appears in the middle of the heart. In this latter projection a calcification lies in the annulus fibrosus, naturally posteriorly and near to the atrioventricular groove. It is therefore easy to differentiate these two kinds of calcification by taking *close-up* pictures in the three classical projections.

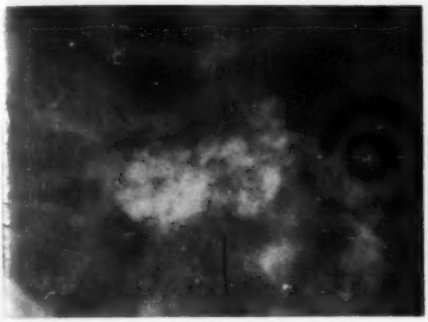

Fig. 6. The same case rotated 30° to the left.

Fig. 7. The same case rotated 30° to the right. The calcification is seen in the middle of the heart.

When describing the roentgen discoveries in his case, HOLMGREN says: »No calcification could be seen in the heart itself in frontal roentgenogram, in which the radiation was *not specially intense*. When the patient was rotated somewhat to the left from the frontal position, this calcification could be clearly seen in the fluoroscope. *Its shape and position resembled that of a typical perimitral calcification in annulus fibrosus.*»

Here HOLMGREN himself has described the typical discovery in a calcification of the aortic root but says that the calcification *resembles a perimitral calcification in annulus fibrosus.*

It is therefore highly probable that HOLMGREN and I have cinematographed intracardial calcifications with different localization and for this reason, amongst others, there can be no question of a comparison.

O. HUBACHER of Bern, gives an account in Acta Radiologica in 1947 of the movement of an intracardial calcification which he considered was situated in annulus fibrosus mitralis or in a mitral valve. HUBACHER has made »fasengezielten Herzaufnahmen» and has come to the conclusion that the course of the movement is rectilinear. »Sie bestätigen die Bemerkung HOLMGRENS dass bei genau sagittalem Strahlengange *nie eine Dreiecksform der Mitralisverkalkungsbewegung, wie sie* ODQVIST *beschreibt, zustande kommt.*» The roentgenograms which HUBACHER submitted with his paper do not either permit of any certain analysis of the position of the calcification. But as HUBACHER, by careful sagittal focussing, gets the calcification to fall partly on the left half of the vertebral column and as,

moreover, he speaks about a *»vergrössertes aortisch-konfiguriertes Herz»* with loud systolic murmurs over various ostia, it would be easy to suppose that, also in this case, there was a calcification of the aortic root. For this reason it is not even possible to compare the course of movement of this calcification with that of the one in the *annulus fibrosus mitralis* studied by me. It is not even certain whether, in the five exposures made by HUBACHER during the cardiac cycle, a triangular course of movement need appear.

As previously mentioned, when making a comparison of the course of movement of an intracardial calcification, it is an absolute sine qua non that the calcification has the same identical topographical position.

In my case I have been able to locate the position of the calcification definitely to the annulus fibrosus mitralis partly by means of roentgenograms and partly by section. HOLMGREN and HUBACHER have not been able to do this either by the one way or the other.

Do all Perimitral Calcifications Move Similarly when Being Cineroentgenographed?

As previously pointed out, it is not only the localization of the calcification which determines the appearance of the movement curve during cineroentgenography. The *condition of the heart muscles* also plays an important part on this occasion.

Even in my first description of the *triangular* course of movement of the mitral ring in my case, I expressed the supposition that this *could* be caused by simultaneous disturbances in the myocardium, dependent on coronary changes. A further study of the cine film has shown me that the divergence in an apical direction of the calcification at the end of a ventricular systole is *similarly expressed in a frontal projection of the patient as in the first oblique projection.* Consequently the calcification moves as much to the left as it does forward at the end of a ventricular systole.

W. BÖHME points out that the papillary muscles, on account of their similarity in structure to the skeletal muscles, have a greater capacity to longitudinal shortening than the other heart muscles and, because of this, form an integrating part of the heart's pump mechanism. When these muscles contract during a systole the closed valves are pulled in an apical direction. Simultaneously with this there takes place, partly a shortening of the longitudinal muscular fibres of the ventricles, which help to pull the valve plane downwards, and partly a contraction of the circular ventricular muscles which further constricts the lumen and brings the papillary muscles closer to each other. *The movement of the mitral ring during the cardiac cycle must then necessarily be dependent on the condition of the papillary muscles and the proximate myocardium.*

Disturbances within the branches of the bundle of His in the wall of the ventricle might even be thought to cause an incoordination in the contraction of the heart muscles. The electrocardiogram in my case showed however, no such disturbance. If there is now a calcification in the annulus fibrosus mitralis and the heart is otherwise unimpaired, *the mitral ring, in all probability, goes down and up in a rectilinear course.* Seen from a purely mechanical point of view, it would appear more expedient that a piston should move in such a manner. If, on the other hand, there are simultaneous pathologic changes in the posterior group of papillary muscles including the posterior ventricular wall, it is probable that an incoordination will soon occur in the muscular contractions with the consequent divergence from the rectilinear course of movement. With this as a basis for my supposition I let a pathologist examine the removed heart more closely, paying special attention to the condition of the papillary muscles.

As a calcification in the annulus fibrosus mitralis always concerns elderly patients, the myocardium is very seldom quite healthy. In both of the cases under my observation there was a coronary sclerosis of a very marked degree. In one of these this was clearly seen on the roentgenograms. Both of the cases concerned women. The same applied to a case which SUNDBERG kymographed. It is otherwise well known that these calcifications in the annulus fibrosus are much more common in women than in men. In both HOLMGREN's and HUBACHER's cases of intracardiac calcification of dubious position it concerned men.

Report of the Patho-anatomic Examination of the Heart

(By Dr. J. MELLGREN, M. D., chief of the pathologic department of Sahlgrenska Sjukhuset.)

The pericardium contained a few drops of highly fibrin-flaked fluid. Its laminae were the seat of minor hemorrhages. All the chambers of the heart were moderately dilated especially the left ventricle. The walls were slightly hypertrophied especially that of the left ventricle. The aortic valves, especially their bases, were grossly calcified, bulkily thickened and adherent to each other; rigid; the ostium somewhat constricted. Around the passage to the coronary vessel, some pea-sized calcareous nodes. *The base of the posterior mitral cusp forms a calcified horseshoe as thick as a pencil,* open in front and to the right. The posterior cusp is shortened. The anterior cusp shows moderate sclerosis with calcification at the base. The cusps are not coalescent, the cordae tendineae and closing edges are, to all intents and purposes, without comment. The ostium is slightly constricted. Close to the base of the posterior mitral cusp there is a thrombus as large as a finger-tip, partially organised and bending in towards the auricular lumen; the thrombus lies in a cavity in the calcified »horseshoe». No endocarditic stratification on the valves themselves. The coronary vessel grossly arteriosclerotic, calcareously hard and constricted. An obturating, cm-long thrombus in ramus circumflex. a. coron. sin. The aorta grossly arteriosclerostic with large sores partially covered with small thrombi. The myocardium slightly grey and dry; *in the posterior wall of the left ventricle there are quite small infarctions*

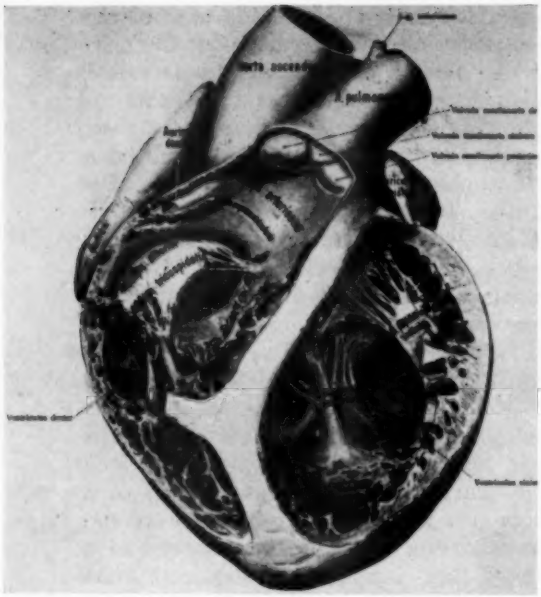

Fig. 8. The opened heart chambers with atrioventricular valvular apparatus.
(RAUBER-KOPSCH: Anatomie d. Mensch.)

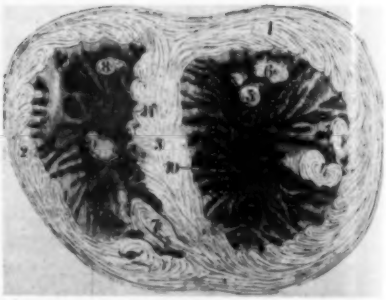

Fig. 9. Cross section through the middle of the ventricles of the heart. 4. Mm. papillares anteriores. 5, 6 Mm. papillares posteriores.
(RAUBER-KOPSCH: Anatomie d. Mensch.)

and a yellow, dry infarct as large as a postage stamp. Close to the »horseshoe» a slight calcification radiates some mm in the myocardium.

Histologic examination of the posterior papillary muscle of the mitral orifice shows *fibrosis in the apex of old date.* Lower down in the papillary muscle, infarct in places with necrosis of the muscular fibres and demarcation by hemorrhagic marginal zones and a small leucocyte infiltration. The infarct continues down into the base of the papillary muscle. Near the base one can also see fresh granulation tissue which partly organises the necrosis. A section from the base of the papillary muscle also shows fresh infarcts with, partly, nests of granulation tissue as well as *infarctions.* A section through *the anterior papillary muscle group shows no macroscopic changes.*

In the posterior papillary muscles then, there were old fibrous changes as well as ones that were fairly old and more recent. In all probability the fibrous changes existed during the cinematography in 1944.

The Anatomy and Topography of the Papillary Muscles

As is known, the mitral orifice closes with two valves — valvulae bicuspidales — of which the posterior cusp lies posterolaterally and attaches itself to the annulus fibrosus sin. The anterior cusp — or great

aortic cusp — lies forwards and to the right and attaches itself chiefly to the aortic root. The papillary muscle group springs from the ventrical wall downwards of the angle between the valves. Thus the *posterior* lies *posteromedially* while the *anterior* lies *anterolaterally*. (Figs. 8 & 9.)

Each group of cordae tendineae springing from the papillary muscles are inserted, half to the one cusp, and half to the other cusp so that when the said muscles contract, the valves not only expand but they also come closer to each other. The cordae tendineae are partly attached to the edge of the valves and partly to the surfaces of the valves facing the ventricle. At the termination of a ventricular diastole the valves lie with the central parts of their auricular surfaces towards each other and during a systole this connection between them becomes more strongly marked as the left ostium constricts ring-shaped thereby causing the greater parts of the valves to come against one another.

The Movement of the Mitral Ring in Pathologic Changes in the Papillary Muscles

If, as in the case described above, there is now a pathologic process in the posterior papillary muscle group and its surrounding parts of the ventricular wall in the shape of infarctions, or inflammation, it follows that the pump mechanism of the heart must necessarily be affected. *The power of contraction is diminished in the posterior papillary muscles whilst that of the papillary muscle group, located anterolaterally, continues to function normally.* From a purely mechanical point of view, the result of this must then be that, at the end of a systole, the mitral orifice must be pulled forward and to the left as the *cine film of this case showed.* A contrary movement ought to occur if the *anterior* papillary muscle group with its surroundings are affected.

In STRÜMPELL's book: »Spezielle Pathologie und Therapie» he says, in a chapter dealing with chronic myocarditis: »Übrigens ist hervorzuheben, dass zuweilen auch bei *reiner Myokarditis* ein systolisches Geräusch an der Spitze gehört wird, welches auf einer relativen Insuffiziens der Mitralisklappe *oder* auf ihren *unvollständigen Schluss infolge fehlerhafter Muskeltätigkeit des linken Ventrikels* (*wahrscheinlich insbesondere der Papillarmuskeln*) *beruht* (*sogenannte muskuläre Klappeninsuffiziens*).»

With regard to my case which has been described above, it is my opinion that the triangular course of movement of the mitral ring, which was visible during cineroentgenography, was caused by just some such faulty muscular activity especially in the *posterior* papillary muscle group.

It seems to me that the above observations of the triangular course of movement of the mitral ring during pathologic changes in the posterior

papillary muscle group and the neighbouring parts of the posterior ventricle wall, give strong support to the theory, related above, concerning the significance of the papillary muscles in regard to the pump mechanism of the heart.

Perhaps, when making a section of the heart, where there are neither anamnestic nor clinical facts pointing to endocarditis but where constant murmurs are audible over the heart, one ought to pay more attention to the appearance of the papillary muscles by making a section of them. In all probability one might then more often find an explanation for murmurs over the heart, diagnosed during life and due to some such muscular insufficiency of a valve.

SUMMARY

From a cineroentgenographic film the author has studied the movement of the mitral ring during the cardiac cycle and has found that this follows a *triangular* course. At the end of a systole the mitral ring moves anterolaterally. Patho-anatomically the heart showed extended fibrous changes within *the posterior papillary muscles and neighbouring part of the posterior ventricular wall.* There was also a marked degree of coronary sclerosis. The author considers that the triangular course of movement was caused by a *muscular insufficiency* in the posterior papillary muscles and its neighbouring region.

ZUSAMMENFASSUNG

An einer Kinoröntgenaufnahme hat Verf. die Bewegungen des Mitralringes während der Herzrevolution studiert und gefunden, dass derselbe eine *dreieckige* Bahn beschreibt. Am Ende einer Systole bewegt der Mitralring sich vorwärts-lateralwärts. Pathologisch-anatomisch wies das Herz ausgedehnte fibröse Veränderungen in *den hinteren Papillarmuskeln und benachbarten Partien der hinteren Kammerwand* auf. Auch ein bemerkenswerter Grad von Koronarsklerose lag vor. Verf. ist der Ansicht, dass die dreieckige Bewegungsbahn durch *Muskelinsuffizienz* der hinteren Papillarmuskeln und des benachbarten Gebiets verursacht war.

RÉSUMÉ

Sur un film cinéradiographique l'auteur a étudié le mouvement de l'anneau mitral pendant le cycle cardiaque et a vu qu'il décrivait une course *triangulaire.* A la fin de la systole l'anneau mitral se déplace en direction antéro-latérale. Du point de vue anatomo-pathologique le coeur présentait des altérations fibreuses extensives *au niveau des muscles papillaires postérieurs et des parties voisines de la paroi ventriculaire postérieure.* Il y avait aussi un degré marqué de sclérose coronaire. L'auteur estime que la course triangulaire du mouvement avait pour cause une *insuffisance musculaire* des muscles papillaires postérieurs et de la région avoisinante.

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FROM THE ROENTGEN CLINIC OF THE STATE HOSPITAL, COPENHAGEN, DENMARK
(CHIEF: PROF P. FLEMMING MØLLER, M. D.)

A CASE OF UNILATERAL PULMONARY AGENESIS WITH IPSILATERAL ABSENCE OF THE DIAPHRAGM[1]

by

Gregers Thomsen

With the great development of thoracic surgery in recent years the interest in, and knowledge respecting congenital anomalies of the thoracic organs has much increased — due to the greater possibilities for treatment, which, however, presupposes a precise diagnosis. Agenesis of a lung is among the rarer anomalies of the respiratory organs, yet it is from a diagnostical point of view of great interest, because the condition is often misinterpreted. Sometimes it is wrongly termed aplasia: but the lung is not aplastic, it is entirely absent, therefore agenesis is the correcter term.

SCHNEIDER has classified defects of this kind into three main types; (1) true agenesis, with no trace of the lung, bronchus or vascular supply to the affected side, (2) a type characterised by a small outpocketing from the trachea but no pulmonary tissue or vascular supply, (3) a type in which the bronchus is fully formed but reduced in size, and the pulmonary tissue transformed into a fleshy mass without alveoli. Cases of the last rather belong to the category for which aplasia is the proper term.

The embryology of the agenesis is obscure. The condition is probably due to a primordial defect in the development of the lung, corresponding to similar defects in other organs, and it is characteristic that other congenital anomalies have often been noted in cases of agenesis of a lung. According to recent investigations (AREY), the two bronchial buds arise in the embryo from the primordial trachea in the fourth to fifth week. These primitive buds by progressive branching eventually give rise to the bronchial tree, from the terminal tubules of which arise small outgrowths which constitute the alveoli. The pulmonary arteries spring from one of the six aortic arches which arise during the fifth to sixth week. Therefore,

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the agenesis must have had its origin very early in embryonic life. Between fifty and sixty cases are on record. In 1920 LEVY reported 20 cases from the literature, since then the number has been nearly tripled. Thus, in 1941 VAN LOON and DIAMOND found another 20 cases, and in 1947 R. A. BURGER brought the list up to date with an additional 12. Most of these cases were from necropsy materials, only a small number, especially from the past few years, had been diagnosed *in vivo*. It may be mentioned, though, that already in 1910 the diagnosis was made roentgenologically, by CHILAIDITI, in the case of a boy ten years of age. That cases are diagnosed oftener now is probably due partly to such improved aids to diagnosis as bronchography and bronchoscopy, partly to preciser knowledge respecting the anomaly. In the roentgen clinic of the State Hospital we have recently diagnosed the following case.

The patient, a woman aged thirty-six, stated that she had been told that when she was three days old she had had a bad cough; but of particulars in that connexion she, of course, could give no information. She had always suffered from shortness of breath and cyanosis after any considerable physical effort. Otherwise no pulmonary or cardiac symptoms, no cough or asthmatic attacks. Never any symptoms referable to the digestive tract, particularly neither pain nor obstipation. As she was complaining of fatigue and lassitude, she was in the fall of 1947 admitted to a hospital in the provinces, where she was found to have a diaphragmatic hernia. On that account she applied for invalidity pension, and was then admitted to the pulmosurgical ward of the State Hospital for further examination and possible treatment.

Objective examination showed a woman of normal appearance but psychically inferior. The left side of the thorax was flattened. Stethoscopy showed dullness and diminished repiration on that side. The cardiac borders could not be made out; the heart sounds were clear. The rest of the examination and the laboratory tests showed nothing abnormal.

Roentgenographic observations of the chest revealed very curious conditions (Fig. 1). There was diffuse densification over the whole left half of the thorax, into which projected the gas-filled stomach and a gas-filled loop of the colon. The heart was not visible. In a strongly differentiating view (Fig. 2) it was seen that the right lung not only filled the whole of the right pulmonic field but extended beyond the midline, especially upwards, so that the densified area was delimited medially by the emphysematous right lung. Besides, there was seen a distinct flattening of the left side of the thorax. In the lateral projection (Fig. 3) the heart was seen situated anteriorly, the stomach and a loop of the colon posteriorly.

Roentgen examination of the esophagus showed that it passed downwards to the left of the vertebral column. It was normal and its course could be followed down to a normally situated cardia. The stomach, with exception of the cardia and the pylorus, was situated up in the thorax, and so was the splenic flexure. No left diaphragm was visible, nor anything that could be interpreted as a hernial orifice. Finally, the trachea was inspected and was found to be displaced to the left, but there were no signs of compression.

The pictures indicated the existence of a considerable defect in, or rather absence of, the left diaphragm, with dislocation of the abdominal organs upwards into the thorax, besides total atelectasis or an agenesis of the left lung. Therefore, bronchography was suggested, but as the patient refused to submit either to this or to bronchoscopy, these investigations had to be omitted, and instead a tomographic study

Fig. 1.

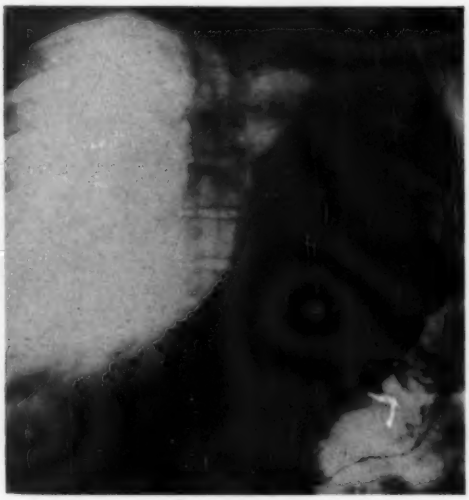

Fig. 2.

was made of the trachea. The tomograms showed that the trachea deviated to the left (Fig. 4). The right main bronchus arose normally, but in none of the films could a left main stem bronchial orifice be seen; the wall of the trachea was quite smooth: without defects. This observation conclusively showed that it must be a case of agenesis.

In order to make the diagnosis of agenesis one must be able to demonstrate the absence of a lung and of the ipsilateral main bronchus. As a rule, there will in the roentgenogram be seen a massive deveiling of the pulmonary field in question, displacement of the mediastinum together with the heart and trachea toward the affected side, high-standing diaphragm and flattening of the thorax. The contralateral lung will be the seat of an emphysema. The picture resembles that of total atelectasis of a lung, and has several times been diagnosed as such. Therefore, the examination of the condition of the main bronchus is determining for the diagnosis, and here bronchography and bronchoscopy — and, as in our case, tomography — are of great value. As already said, defects in other sites are common accompaniments of the pulmonary agenesis. There may be unilateral failure of kidney development (ELLINGSWORTH and HIBBS), atresia of the anus (RIENHOFF), congenital heart disease and

Fig. 3. Fig. 4.

developmental defects of the contralateral lung (BURGER). According to CAFFEY, anomalies of the vertebral column are particularly common. In our case, there was a defect in the left diaphragm (or perhaps it was totally absent), with resulting displacement of the abdominal organs upwards into the thorax. A similar case was described by HANSON in 1901. He found at postmortem examination agenesis of a lung and at the same time a defect in the diaphragm and the thoracic cavity filled with intestinal viscera. It may perhaps be discussed if the agenesis in our case was due to a fetal atelectasis owing to the defect in the diaphragm, with subsequent atrophy of the lung. As the lungs during fetal life already beforehand lie closely folded together owing to the position of the fetus and the absence of air-content, and as, moreover, the pressure from the abdominal organs is not very great, the atrophy would probably not develop until after birth, and if so it would be possible to demonstrate a rudimentary lung. But no such rudiment was present. Besides, it can by roentgen examination of congenital defects in the diaphragm, hernias or absence of the diaphragm be demonstrated that the atelectatic lung is present, as will be seen from the following case.

The patient was a girl three years old, admitted to the State Hospital for diaphragmatic hernia. The physical examination revealed nothing significant. Roentgen examination of the gastro-intestinal tract showed a normal stomach in normal position. The whole small intestine, from the duodenum to the terminal loop of the ileum, and the whole colon except the descending portion lay in the right half of the thorax; besides, the intestine was not rotated. On this side no diaphragm was seen, neither were there any signs of a hernial orifice. It was probably a case of absence of the diaphragm on the right side.

Fig. 5.

In this connexion it is particularly to be noted that there was a triangular shadow situated upwards in the right apex and extending along the superior mediastinum, and which in all probability represented the atelectatic right lung. Besides, one sees in the same film (Fig. 5) the right bronchus with all its branches.

As the case history of our patient shows, the absence of one lung is not incompatible with life. Several patients with this defect have lived to an advanced age. HEERUP, for instance, found at postmortem examination pulmonary agenesis in a woman aged seventy-two years, who had died of cerebral hemorrhage. The anomaly may exist without revealing itself by any symptoms. Thus, it was found by JARISCH in a soldier who had served through the first World War without experiencing any trouble from his defective lungs. When symptoms are present, it is oftenest in the form of functional dyspnea. Many die, however, at a very early age, as a rule of pneumonia, which of course in these patients is particularly dangerous. Besides, the often accompanying defects in other organs may compromise life.

For causes unknown, the left lung has been the affected one nearly twice as often as the right. If we rubricate the reported cases according to SCHNEIDER's classification, we find his first type represented nearly five times as often as his second. No sex predilection is evident in the

reported cases. Finally, it must be mentioned that an absolutely identical roentgenologic picture is found in cases of »acquired agenesis» following pneumonectomy.

SUMMARY

After briefly reviewing the literature on the subject, the author describes a case of agenesis of the left lung and absence of the diaphragm on the same side, in a woman aged thirty-six years. The diagnosis is discussed, with particular emphasis on the demonstration of the absence of the corresponding main bronchus, and, finally, the differentiation of agenesis from total atelectasis of the lung due to location of the abdominal organs in the thoracic space.

ZUSAMMENFASSUNG

Nach einer kurzen Übersicht des einschlägigen Schrifttums beschreibt Verf. einen Fall von Agenesie der linken Lunge und Fehlen des Zwerchfells derselben Seite bei einer sechsunddreissigjährigen Frau. Die Diagnose wird erörtert, mit besonderer Betonung des Nachweises des Fehlens des entsprechenden Hauptbronchus, und schliesslich die Unterscheidung einer Agenesie von vollständiger Atelektase der Lunge durch Verlagerung der Bauchorgane in die Brusthöhle besprochen.

RÉSUMÉ

Après un court aperçu de la littérature du sujet l'auteur décrit un cas d'agénésie du poumon gauche avec absence du diaphragme du même côté chez une femme de 36 ans. Le diagnostic est l'occasion d'une discussion où sont spécialement soulignées la mise en évidedce de l'absence de la bronche principale du côté correspondant, ainsi que, pour finir, l'importance qu'il y a à différencier de l'agénésie l'atélectase totale du poumon due à l'envahissement de l'espace thoracique par les organes abdominaux.

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FROM THE ROENTGENDIAGNOSTIC DEPARTMENT OF THE CAROLINE HOSPITAL, STOCKHOLM (CHIEF: PROFESSOR Å. ÅKERLUND) AND THE SAMARITEN, CHILDREN'S HOSPITAL, STOCKHOLM, SWEDEN (CHIEF: PROFESSOR N. MALMBERG).

CONGENITAL VALVULAR FORMATIONS IN THE URETHRA[1]

by

Sigvard Jorup and *Sven Roland Kjellberg*

It is evident that the congenital formation of valves within the urethra are relatively uncommon, but none the less, it is very important to know about them, as they are often directly dangerous to life especially in the case of newly born children. As a rule, these valves appear in the posterior part of the urethra, usually in close association with the colliculus. As their etiology is considered as being due to some disturbance during development, a short resumé of the development of the urethra will be given here.

At a very early stage in the development of the fetus, the entodermal cloaca is divided by the urorectal fold into a ventral urogenital duct and a dorsal anal duct, the rectum. The urogenital duct forms the common origin of the bladder, the urethra and the urogenital sinus. Into this open both of the primary urinary ducts, known as the Wolffian ducts. By degrees the inferior parts of the Wolffian ducts expand more and more until they form a part of the posterior wall of the urogenital duct (see Fig. 1). At this stage of development the definite ureters will open directly into the urogenital duct. In the meantime, the partition between the openings of the ureters and those of the Wolffian ducts develops. This causes the openings of the ureters to project in a cephalic direction and those of the Wolffian ducts to project in a caudal direction. Gradually a slight constriction will be observed within the upper part of the urogenital duct which demarcates the border line between the bladder and the prospective urethra. Subsequently the origin of the bladder grows rapidly in size whilst the primary urethra remains narrow and short. The upper margin of the urethra lies against the above mentioned constriction whilst the lower edge lies at the opening of the Wolffian ducts. That part of the

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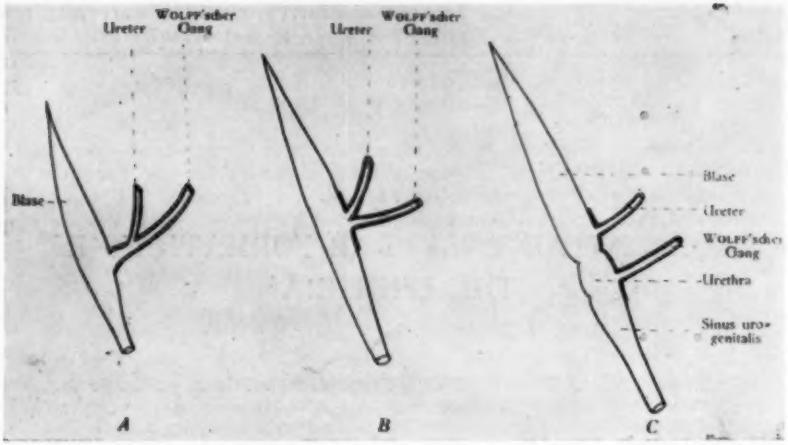


Fig. 1. Diagram of the displacement of the lower openings of the ureters (from BROMAN).

urogenital duct which lies caudal to this point of entry becomes the urogenital sinus which develops differently in both sexes. In males it forms the lower part of the pars prostatica, the entire pars membranosa and the posterior part of the pars cavernosa of the urethra. In females, on the other hand, it forms the vestibulum vaginae.

In the beginning, the lumen of the urethra has the appearance of an even, smooth duct, but during the process of development the mucosa begins to form a fairly large number of longitudinal folds. The first longitudinal fold which is formed lies on the rectal side of the pars prostatica. This fold is the origin of the colliculus or verumontanum. The Wolffian and Müllerian ducts pass trough its mesenchyme and open out on the top of it. This is the largest, most constant and most significant fold. The other folds come later, both above and below the colliculus.

Numerous theories have been expounded on the etiology of the congenital valves. Many authors agree with TOLMATSCHEV that they originate from the folds and ridges which appear normally within the prostatic urethra, for the simple reason that these develop to an abnormal extent. In this way they bring about a partial obstruction to the passage of urine. By means of the pressure caused by the passing urine, these folds which constrict the lumen are pressed out and stretched. Thus the folds become more and more deformed and distended, until at last they take on a typical valvular character. There is, of course, no absolute proof of this theory but nevertheless it seems plausible.

The congenital valves mainly occur within the posterior urethra, usually in close connection with the colliculus. They are folds or duplications of the mucosa, which cause a greater or lesser obstruction to the flow of the urine according to the size of the folds. They lie like fins in the lumen and become distended during micturition in about the same way as valves in the veins. There are three different types of these valves.

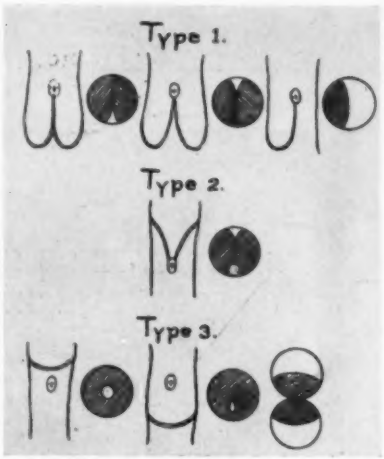


Fig. 2. Diagram of the position and appearance of the congenital urethral valves (from YOUNG, FRONTZ and BALDWIN).

The first type (see Figs. 2 and 3), is characterized by a prominent fold which runs downwards from the colliculus and gradually divides into two thin fins which are fixed to the walls of the urethra peripherally but which are more or less free centrally. Occasionally one comes across a case where there is only one fin.

In the *second type* (see Fig. 2) there is, as in the first type, a common prominent fold, but this runs upwards from the upper part of the col-

Fig. 3. A congenital valve of type 1 (from v. LICHTENBERG, VOELCKER and WILDBOLZ).

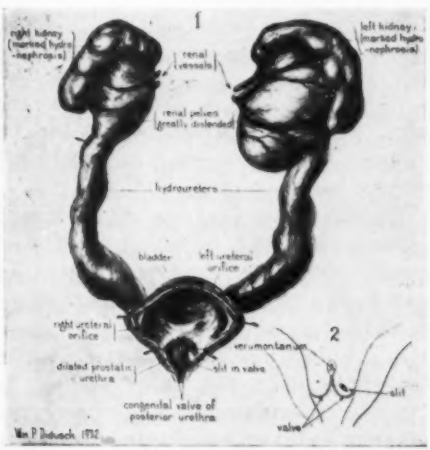


Fig. 4. Considerable dilation of the urinary tract above a congenital valve of type 1 (from LOWSLEY, KIRWIN).

Fig. 5. Fig. 6.

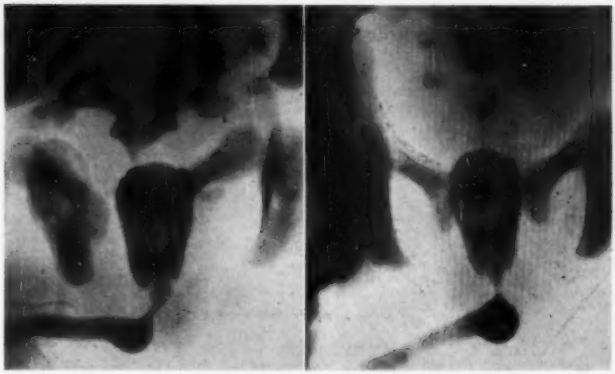
Fig. 5. Case No. 1. Markedly distended bladder with hypertrophic wall and trabeculation. The valvular formation is seen immediately below the colliculus.

Fig. 6 shows a stillborn fetus with dilation of the bladder, ureters and renal pelvis caused by valve formation within the posterior part of the urethra (from PFAUNDLER, SCHLOSSMANN).

liculus. This then branches off into two thin fins which are fixed immediately below the inner urethral orifice in the same manner as in the previous case.

The *third type* (see Fig. 2), differs from the other two, inasmuch as the valve has the appearance of a diaphragm-like membrane which extends completely over the lumen. This type of valve can occur anywhere within the posterior urethra and has no direct connection with the colliculus.

On account of the obstruction which these valves bring about in the passage, the urine stagnates within the part of the urinary tract lying above the obstruction and the pressure increases. This causes these parts to become more or less dilated according to the degree of the obstruction (see Fig. 4). The bladder is usually distended, and, because of the increased resistance against which it has to work, the walls become hypertrophied and trabeculated (see Fig. 5). Sometimes, one comes across diverticula-



7 a. 7 b.

Fig. 7. Case No. 1. Fin-shaped valve formations of type 1.

formations. In the majority of cases, even the neck of the bladder becomes hypertrophic and bulges prominently into the bladder. If the flow is seriously hampered, the renal pelvis and the ureters also become dilated. On account of the increased pressure in the pelvis, the kidney parenchyma is reduced and the function of the kidneys deteriorates. In a large number of patients one finds the presence of residual urine, and an increase in N. P. N. This dilatation often appears in intrauterine life and can be so great that it causes a mechanical obstruction to parturition, a fact which is evident from the literature (see Fig. 6 which is taken from »Handbuch der Kinderheilkunde» by PFAUNDLER and SCHLOSSMANN). This fact, that dilation even occurs in intra-uterine life, indicates the occurrence of secretion from the kidneys during fetal life. Opinions concerning this, however, differ, as will be gathered from a perusal of the literature. Nevertheless, it may now be presumed that secretions from the kidneys have been proven. This is evident from experiments which have been carried out lately by RUDHE and KJELLBERG at the Caroline Hospital when they injected diodrast into an umbilical vein of the fetus. These experiments will be described in more detail in a future paper.

In order to prevent further enlargement of the urinary apparatus over and above that which has taken place in intra-uterine life it is essential that these patients should come under treatment as soon as possible after birth. Symptoms often present themselves at birth or immediately after, but they can occur later. Usually the picture is characterised by the fact that the urinary jet is weak or begins to be weak: often it drips or flows incessantly from the urethra. The bladder, which

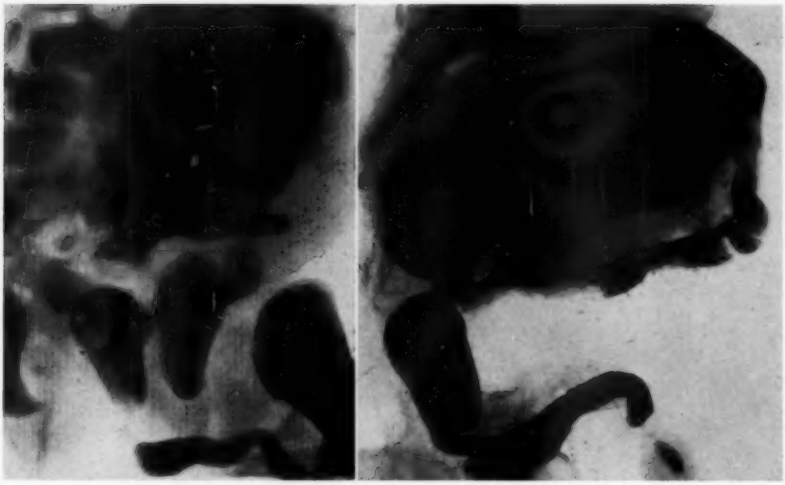


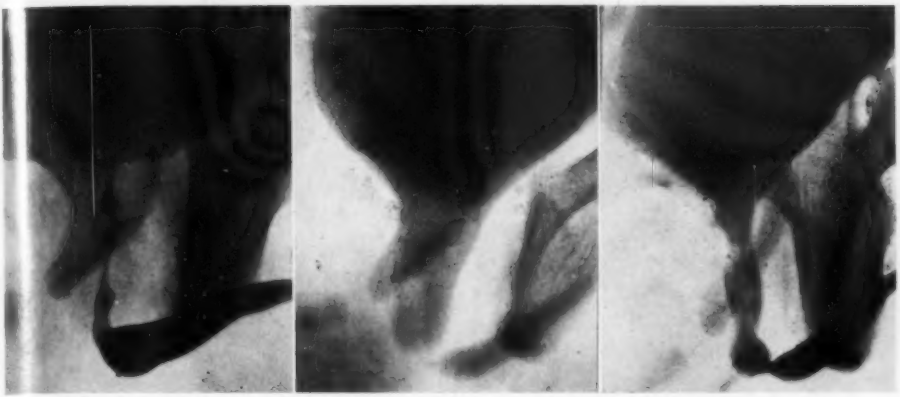
Fig. 8. Fig. 9.

Fig. 8. Case No. 1. The bladder is markedly distended with hypertrophic and trabeculated wall. The neck of the bladder is markedly hypertrophic.

Fig. 9. Case No. 1. Sectional post mortem preparation of the urethra and bladder which have been filled with roentgen contrast medium.

has become more or less hypertrophed on account of the increased resistance, is palpated, as a rule, as a hard, taut mass somewhere between the umbilicus and the symphysis. Sometimes, however, the symptomatic picture can be extremely mild and it can happen that the only symptom is an infection of the urinary tract, as in prostatic hypertrophy.

As a rule it is easy to make a roentgenological diagnosis provided that urethrocystography is performed. Generally speaking, no very great difficulties are encountered, even with new-born children, if a suitable cannula is used. If the valves are prominently developed, the diagnosis can even be made from the injection pictures, but usually they appear only on the micturition pictures, which depends on the aforementioned valve mechanism. It is important to know this from a practical point of view. If the valves can only be demonstrated on the micturition films, they will be much more difficult to identify by means of clinical examination and cystoscopy. In order to be able to show these valves at a clinical examination it is necessary to use an instrument which, after having been inserted, can hook on to the valves and distend them. If a suprapubic cystotomy is performed, a thin sound can be passed into the urethra from above and then drawn down along the walls of the urethra. It will



10 a. 10 b. 10 c.

Fig. 10. Case No. 2. Valve formation of type 1. a) an injection picture. b) a micturition picture. The valve formation appears only on the micturition picture. c) micturition picture after operation. The posterior urethra is now less dilated.

then be possible for the sound to come down into the pockets themselves and fasten there. Another feasible method would be to pass a thin sound, with a hook-formed curve at the point, through the external orifice. When the sound has passed the site of the valves it is then pulled gently back. It may then hook itself on to the valves. Even if the posterior urethra is well visualised by the urethroscope, the valves may be overlooked. This instrument, however, cannot be used on infants because the urethra is too narrow.

Usually it is easy to obtain a good cystographic micturition picture, even on new-born children, if one gives the patient doryl or prostigmine. The dose which is considered sufficient during the first months of life is 0.3 cc (= 0.08 mg carbacholum or 0.17 mg neostigmine bromide) which is injected subcutaneously.

The roentgen picture of valvular formations within the urethra is usually quite typical. In order to be able to judge these formations properly it is necessary, however, to inject a roentgen contrast medium, which is soluble in water, into the urethra. As a rule it is difficult to make a sure diagnosis using only the intravenous urographic method, because of the stagnation of urine above the obstruction. If the valves are prominent and more or less fused in the centre they will appear in their entirety even on the injection pictures and then as thin, fin-shaped defects in the contrast (see Fig. 7). If, on the other hand, the valves are more or less free centrally and lie fixed along the walls as do valves in

Fig. 11.

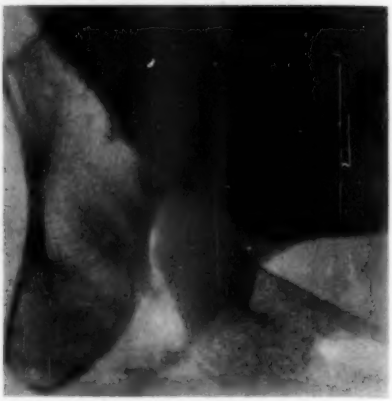


Fig. 12.

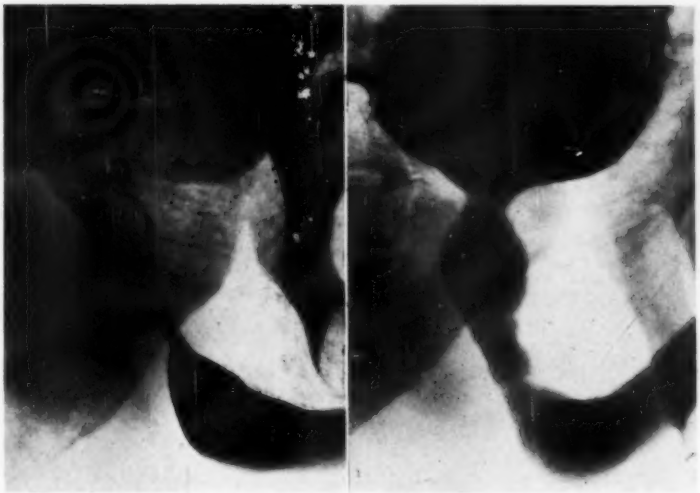
Fig. 11. Case No. 3. A valve formation of probably type III. The prestenotic posterior urethra is markedly dilated. The neck of the bladder bulges posteriorly.
Fig. 12. Case No. 4. Valve formation of type II.
Fig. 13. Case No. 4. Dilation of ureter and renal pelvis on the left side caused by urethral valves.

Fig. 13.

veins, they only appear on the micturition pictures. The prestenotic posterior urethra on such pictures is usually greatly dilated with, inferiorly, a convex or slightly conical surface of limitation (Fig. 10 b), Usually, however, the thickness of the valve itself cannot be determined. On account of the obstruction in the passage only a thin ribbon of contrast medium is observed in the urethra below the valve formation (Fig. 15 b).

Case Reports

Case No. 1. K. S. 3 weeks old. Figs. 5, 7—9. Full term male child who has had excessive frequency since birth. The mother has never observed any proper jet of urine. Abdomen swollen, the bladder is palpated three finger breadths above the symphysis. Increased N. P. N. A strong flow of urine follows prostigmine but there is no vigorous jet. On the left side at the site of the kidney a mass can be palpated which increases in size simultaneously with the beginning of urination following an injection of prostigmine.



14 a. 14 b.

Fig. 14. Case No. 5. a) an injection picture. b) a micturition picture. It is only on the micturition picture that the valve formations appear within the posterior urethra.

Roentgen. Both on injection and during micturition two large fin-shaped valves, emanating from the inferior part of the colliculus, appear within the inferior part of the posterior urethra, thus causing a considerable obstruction to the flow. Marked distention of that part of the posterior urethra which lies above. The bladder is large and distended and markedly trabeculated. The walls of the bladder are greatly thickened. The neck of the bladder is thick and swollen and indents greatly into the bladder. Considerable dilatation of the ureters as well as the pelvis of the kidneys on both sides. Reduction of kidney parenchyma on both sides.

When the patient was admitted to the Children's Hospital »Samariten» its condition was so bad that no immediate operation could be performed. A catheter was inserted but the condition became worse and the child died.

Case No. 2. N. E. D. 5 years old. Fig. 10 a—c. For about one year there has been an infection of the urinary tract together with nocturia and repeated pyelitis. Residual urine varied between 45 and 150 grams.

Roentgen. On micturition a greatly developed valvular formation was observed immediately below the colliculus, which, to a marked degree, renders the flow more difficult. The posterior urethra is dilated to a marked degree above the stenosis. The bladder is markedly trabeculated and on the left side one can see a few small diverticuli. The pelvis of the kidney and the ureters are considerably dilated. No obstruction of the passage can be observed on the injection pictures.

Operation was performed with excision of the valve formations. A considerable improvement followed this. Insignificant residual urine.

15 a. 15 b.

Fig. 15. Case No. 6. a) an injection picture. b) a micturition picture. It is only on the micturition picture that the valve formations appear within the posterior urethra.

Three weeks after the operation fresh roentgen photographs were taken which showed that the valve formations had, to all intents and purposes, disappeared entirely. No prestenotic dilation of the posterior urethra was present (see Fig. 10 c).

Case No. 3. L. Å. H. 5 years old. Fig. 11. Ever since infancy has always had to pass water more frequently than normal. The jet has been very weak and, on micturition, only a very small quantity of urine has been passed. Frequent infection of the urinary tract. Residual urine approximately 200 grams.

Roentgen: A valve formation which rendered the flow considerably more difficult is noticeable within the posterior urethra above the colliculus. On account of this obstruction to the flow, the upper part of the posterior urethra is excessively dilated, the neck of the bladder is hypertrophic and projects from behind into the bladder. The bladder is trabeculated. Considerable distention of the pelvis of the kidneys and the ureters.

There was a considerable improvement after electroresection; residual urine was slight or absent. A very marked decrease in hydronephrosis as well as in hydro-ureter.

Case No. 4. N. L. A. 21 years old. Figs. 12 and 13. Incontinence ever since birth. Urine has come in drops and entirely uncontrolled. During coitus, ejaculation takes place in drops only and is mixed with urine. The remainder of the ejaculation empties itself later on and in connection with the passage of urine.

Roentgen. On a level with and above the colliculus can be seen a prominent valve formation which renders the flow very much more difficult. The upper part of the posterior urethra is markedly dilated and communicates with the bladder by means of a

funnel-shaped opening. The bladder is markedly trabeculated. Both the renal pelvis and the ureter on the right side are considerably dilated.

Operation. Electroresection. Posteriorly, in the urethra, one can see a broad barrier which stretches from the colliculus right up to the markedly hypertrophic and incurving neck of the bladder. After resection the patient gradually became entirely free from trouble.

Case No. 5. F. E. L. 23 years old. Figs. 14 a & b. Ever since he was 15 years old he had been troubled with frequent, precipitant urination. Had to urinate 2 or 3 times every night. Venereal disease denied.

Roentgen: 2 thin valvular formations observed during micturition within the posterior urethra immediately below the colliculus. These caused a slight obstruction of the passage. The bladder was slightly trabeculated and on the left side a small diverticulum could be seen. These valvular formations could not be observed when the contrast medium was injected.

Case No. 6. K. J. H. 37 years old. Figs. 15 a & b. Had been incontinent during recent years. Spontaneous urination in the form of small drops every fifth minute. When the patient urinated voluntarily the flow was fairly good. Found it difficult to begin urinating. Residual urine up to 500 grammes. N. P. N. increased.

Roentgen: Clear signs of a chronic obstruction in the passage with a markedly trabeculated bladder and small diverticular formations. On micturition pictures a valve-like obstruction to the flow appears on a level with the colliculus but this does not appear on injection pictures. The posterior urethra is extremely dilated on a level with and above the colliculus.

After electroresection, the patient's condition improved considerably. Residual urine and N. P. N. decreased.

Fresh roentgen photographs taken a week after the operation showed, however, a more or less unchanged picture.

SUMMARY

An attempt has been made to show the necessity of making an early diagnosis of congenital urethral valves in order to avoid a pathological enlargement of the urinary apparatus. The diagnosis is usually easy to make with the help of urethrocystograms. In a large number of cases valvular formations make their appearance first on micturition pictures of the urethra. Roentgen examination must therefore be carried out both during the micturition phase of the examination and during injection of the contrast medium. The typical roentgen pictures are described.

ZUSAMMENFASSUNG

Die Verff. betonen die Notwendigkeit der Frühdiagnose der kongenitalen Urethraklappen zur Vermeidung einer pathologischen Erweiterung des Harnapparats. Mit Hilfe eines Urethrozystogramms ist die Diagnose im Allgemeinen leicht zu stellen. Bei vielen Fällen treten die Klappenbildungen erst in Miktionsbildern der Urethra hervor. Die Röntgenuntersuchung muss deshalb immer sowohl während der Einspritzung von Röntgenkontrastmittel als auch während der Miktion vorgenommen werden. Das typische Röntgenbild wird beschrieben.

RÉSUMÉ

Les auteurs soulignent la nécessité de diagnostiquer précocement les valvules congénitales de l'urèthre afin d'éviter une dilatation pathologique, de l'appareil urinaire. A l'aide de l'uréthro-cystographie le diagnostic est généralement facile à poser. Dans un grand nombre de cas les formations valvulaires ne ressortent que sur les images de l'urèthre prises au moment de la miction. Voilà pourquoi l'examen radiologique doit toujours se faire aussi bien pendant l'injection de la substance opaque que pendant son expulsion. Description de l'image radiographique typique.

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ROM THE ROENTGEN CLINIC OF THE TOWN AND COUNTY HOSPITAL, VIBORG, DENMARK
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A CASE OF OSTEOCHONDRITIS DISSECANS OF THE ANKLE[1]

by

Thor Narvestad

The name *osteochondritis dissecans* was suggested by F. KOENIG in 1905, but the pathologic condition was recognised already in 1738, by ALEXANDER MORE (»Part of the Cartilage of the Joint separated and ossified»; Med. Essays and Observations *4:* 19, 1738). Its nature has been the subject of discussion and its etiology is uncertain, but by most authors it is now considered as belonging in the group of so-called aseptic necrosing lesions of bone which includes Kienboeck's disease, Calvé-Legg-Perthes' disease, Koehler's, Osgood-Schlatter's, and others. C. E. VAUGHAN & J. C. STAPLETON define it as »an aseptic necrosis of subchondral bone and the overlying cartilage», and say that »usually a small area of bone adjacent to the articulating surface is affected. When it becomes necrotic, the overlying cartilage is devitalised, and frequently the entire fragment separates out and forms an intra-articular loose body.» G. WAGONER & B. N. COHN say that »osteochondritis dissecans is a non-infectious process involving the articular cartilage and the subchondral bone of certain long bones of the extremities, which, by sequestration from the articular surface, usually produces a single foreign body or, more rarely, two, in the contiguous joint. This body is originally often of an osteocartilaginous composition, but its structure subsequently undergoes alteration by the fluid of the joint.» It seems to be a constitutional disease, and both familial occurrence and multiplicity have been demonstrated. Thus AAGE NIELSEN found bilateralism in 26 per cent of cases in the capitellum of the humerus. The lesion oftenest occurs in young adults, especially in males.

Frequently there is a trauma in the anamnesis. Traumata figure, for instance, in the histories of all the cases of osteochondritis dissecans of the ankle reported by SCHNABERT, RABL, BUCKEY & GROW, COBEY and

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MENSOR & MELODY. SCHNABERT believes that repeated injuries, such as sustained, for instance, in skiing, may be a contributing factor. CONWAY thinks that lesion of some end artery due to a trauma is the most logical explanation, the resulting injuries to vessels and the formation of thrombi giving rise to necrosis of a small area, followed by sequestration of a fragment of the surface of the joint. VAUGHAN & STAPLETON feel that trauma is the major factor, though it is not unusual for more than one joint in the same patient to be affected without there being any definite history of injury.

The knee joint is the articulation oftenest involved (according to CONWAY 85 per cent of cases occur in that situation), next in frequency come lesions in the elbow- and hip joint. In the ankle, the condition is rather uncommon. Its most frequent situation there is the medial edge of the trochlea of the talus. VAUGHAN & STAPELTON have recently described 4 cases of osteochondritis of the ankle joint. So far as I know, 24 cases have been published prior to these. Among them is one bilateral, mentioned by G. AXHAUSEN in the Zentralblatt f. Chirurgie *55:* 323, 1928. MENSOR & MELODY, in their review in 1941, recommended the use of tomography as a diagnostic aid in the demonstration of the condition in the ankle. VAUGHAN & STAPLETON think, however, that routine roentgenography suffices, and the lesion is then best seen in oblique views. The following case may be of interest as addition to the comparatively few hitherto published of this affection.

Case Report

The patient was a farm hand aged twenty-two. No history of previous illness. On Oct. 15th, 1946, he was in a runaway, the horses before a loaded farm waggon bolting and one of the wheels going over his left foot. Besides, he got concussion of the brain and a fracture of the bones on the nose. He was admitted to the Hobro Hospital and stayed there for two weeks. A report from the hospital states that films of the left ankle region showed a very small fragment between the external malleolus and the talus. The impression was that it was a case of fracture. On Oct. 28th a plaster bandage was applied from knee to toes, enabling him to walk; on the following day he was discharged. On Nov. 23rd the bandage was removed. The ankle joint was stiff and walking exercise treatment was instituted. The patient states that ever since he has hardly been able to use the foot properly owing to pain in the ankle joint and has not been able to do his full part in the farm work, but only to help in the stable. He says that he got an indemnity of 700 crowns from the insurance company.

On May 13th, 1947, he was called up for military service in the infantry. After he began his service, the pain and restriction of movement in the ankle joint got considerably worse, and in the evenings the joint was swollen. The pain usually increased toward evening. It was localised to a point about 2 cm. in front of the lateral malleolus. During the night it was sometimes severe. There does not seem to have been any locking. Most of the time he was exempted from service in the ranks. From Aug. 9th to 20th he was in the Military Hospital in Viborg with the diagnosis: affection following contusion o

Fig. 1.

Fig. 2.

the foot. After being discharged from there he took part in the exercises for half a day, but had to give up owing to pain in the foot and was then assigned to barracks service in the kitchen.

On Aug. 22nd he was examined in the roentgen clinic of the Viborg Town and County Hospital. Films of the left ankle region showed no sure signs of fracture. In the upper lateral corner of the talus there was seen a small, about bean-sized rarefaction, and in this a sclerotic shell-shaped fragment about 1 cm. long (Figs. 1—3). There was some slight sclerosis about the rarefied area, but on the whole its demarcation was rather vague. There were no signs of arthritis. The articular interspace was normal. The impression was that the condition observed was due to osteochondritis dissecans of the talus, with a small loose body. Roentgen examination of the right ankle showed normal conditions. *Roentgenologic diagnosis:* Osteochondritis dissecans of the left talus.

At a second roentgen examination here on Sept. 26th, 1947, the patient stated that he was still in military service, but doing duty in the barrack kitchen. He still had pain on walking, though less so when he wore wooden shoes, as he did while working. He could not wear ordinary shoes or boots. As a rule, the foot became swollen afternoons and evenings, most about the lateral malleolus. On the whole the pain had of late been less severe and subsided when he was resting.

Fig. 3.

Physical examination: There was now no swelling of the left lower extremity, but still tenderness over the lateral malleolus and about 2 cm. anterior, posterior and inferior to the latter. All movements of the left ankle joint were restricted and painful. When walking, he limped a little and held the left foot fixed.

	Left	*Right*
Plantar flexion	20—25° (passive: 30°)	45°
Dorsiflexion	about 10° (» 20°)	40°
Rotation inwards	5°	40°
» outwards	about 15°	40°

We have not seen the patient since, and have had no information about the subsequent course of his case.

Comment. — In an otherwise healthy young man, roentgen examination immediately after an injury to the ankle region demonstrated sequestration of a small fragment from the lateral edge of the trochlea of the talus. Despite plaster bandage for a month, there were during the following time persistent symptoms from the joint, in the form of pain and restricted motion, especially in connexion with any strenuous physical effort. Roentgen examination ten months after the trauma had been sustained showed signs of osteochondritis dissecans. Though the case was not subjected to surgery and thus not operatively proved, the picture was so typical that it must be considered as a case of osteochondritis dissecans of the talus. Etiologically, the case is peculiar by the fact that the symptoms manifested themselves in full strength immediately after the injury had been sustained. This excludes the possibility that the trauma should have produced its effect in the manner usually supposed, through lesion of an end artery and secondary sequestration of a necrotic bone fragment. Neither is it likely that it should have directly caused sequestration of a fragment from the edge of a sound trochlea, since the latter lies well protected in the fork of the ankle joint. Therefore it is most reasonable to presume that it has caused an already existing osteochondritis dissecans with superficial necrosis of the bone to become active through the separating off of the fragment in question.

SUMMARY

The author relates the case of a man aged 22 years, never previously ill, who on 15th October, 1946, was involved in an accident by which he sustained an injury of his left foot. Despite treatment (plaster of Paris bandage) he is since still having pain in the foot, and its mobility is restricted. At roentgen examination 22nd September, 1947, osteochondritis dissecans and the presence of a small loose body in the foot were demonstrated.

ZUSAMMENFASSUNG

Verf. beschreibt den Fall eines bisher immer gesunden, 22jährigen Mannes, der am 15. Oktober 1946 einen Unfall erlitt, wobei er eine Verletzung des linken Fusses erhielt. Trotz Behandlung (Gipsverband) hat er seitdem noch immer Schmerzen im Fusse, der eine Einschränkung der Beweglichkeit aufweist. Bei Röntgenuntersuchung am 22. September 1947 wurden Osteochondritis dissecans und die Gegenwart eines kleinen freien Körpers im Fusse nachgewiesen.

RÉSUMÉ

L'auteur relate le cas d'un homme de 22 ans, sans antécédants pathologiques, qui le 15 octobre 1946 subit un accident au cours duquel son pied gauche fut blessé. En dépit du traitement (appareil plâtré) il continua depuis lors à souffrir de ce pied, dont la mobilité est diminuée. Un examen radiologique, le 22 septembre 1947, révéla une ostéochondrite disséquante et la présence d'un petit corps libre à l'intérieur du pied.

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ON AXIAL PROJECTION OF THE SHOULDER-JOINT[1]

by

Folke Knutsson.

Axial roentgenograms of the shoulder ought to be taken in a manner as to secure an axial projection of the glenoid fossa. The study of such roentgenograms provides an exact estimate of the position of the humeral head relatively to the glenoid. I have observed that the most convenient way of obtaining this positioning was to take the roentgenograms with the radiation in horizontal direction, and with the patient lying, the arm being abducted 90 degrees. The central rays are directed to the axilla and the film is placed in epaulet position on the shoulder. The examinator being standing and holding the patient's arm is thus enabled to make a roentgenographic study of the shoulder-joint with the arm in different positions (fig. 1.).

In cases with habitual dislocation it is by that means possible to take photographs in conditions of subluxation or dislocation of the head. (Fig. 3 & 4.)

Fig. 1. Technique. The patient is lying on a wheeled stetcher.

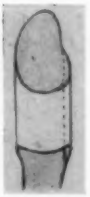

Fig. 2. Diagram of the axial projection of the glenoid in normal conditions.

[1] Submitted for publication, June 1, 1948.

a. b. c.

Fig. 3. Recurrent dislocation, a) in neutral position, b) in forward subluxation, c) the normal shoulder. Observe the double outline of the anterior glenoid margin present in the normal shoulder, absent in the shoulder-joint in which there is subluxation.

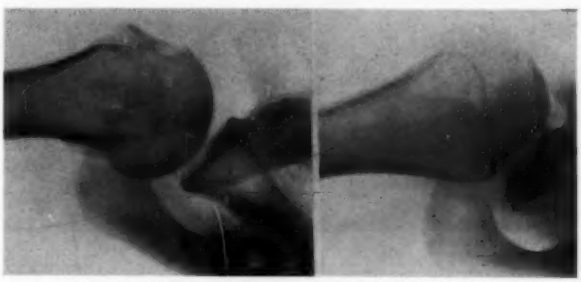

Fig. 4. Recurrent dislocation in neutral position and in forward sliding of the head.

The glenoid has not entirely an equable elliptical circumference, the lower part of the anterior glenoid margin being indeed more prominent than its upper portion. In axial projection this anatomical condition ensures, as it is easy to understand, a double outline of the anterior glenoid lip (Fig. 2, 3, 5). In cases with recurrent dislocation there is often no evidence of this double outline, and the anterior margin is uniformly smooth and rounded (Fig. 2, 3, 5). JAKOBSSON observed this roentgenographic finding when studying a larger series of appropriate cases. In his opinion the projecting part of the anterior glenoid margin was found to be rounded and eburnated on account of repeated subluxations or dislocations.

The film taken in axial projection also determines precisely the position of the bone graft at the Eden-Hybbinette operation on the anterior glenoid rim in conditions of recurrent dislocation of the shoulder-joint (Fig. 6).

a. b.

Fig. 5. a) Shoulder-joint with recurrent dislocation, b) normal shoulder-joint. There is a double outline of the anterior glenoid margin in the normal shoulder which is not detectable in the shoulder-joint with recurrent dislocation.

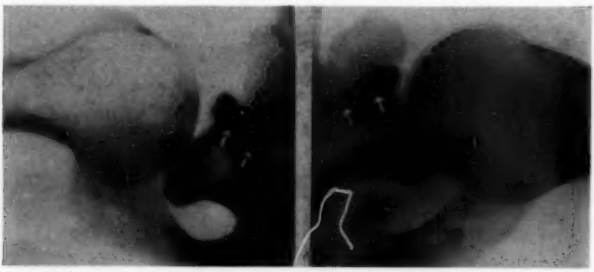

Fig. 6. Roentgenogram showing the graft in correct position at the anterior glenoid rim, after Eden-Hybbinette's bone block operation.

SUMMARY

Axial projection of the shoulder-joint may suitably be carried out in decumbent position, with the arm kept from the trunk in 90 degrees abduction, and with horizontal radiations.

ZUSAMMENFASSUNG

Die axiale Projektion des Schultergelenks wird zweckmässig in liegender Stellung mit im rechten Winkel gegen der Körper abduziertem Arm und wagerechter Strahlenrichtung aufgenommen.

RÉSUMÉ

La projection axiale de l'articulation de l'épaule peut s'obtenir de façon adéquate le sujet étant en position coucheé avec le bras en abduction à angle droit par rapport au corps, et le rayon normal se dirigeant horizontalement.

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FROM THE ROENTGEN DEPARTMENT OF MARIA HOSPITAL, HELSINGFORS, FINLAND
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PRIMARY MALIGNANT TUMOURS IN THE SMALL INTESTINE, WITH SPECIAL REFERENCE TO THEIR ROENTGEN DIAGNOSIS[1]

(A survey, and a report of one case)

by

Rolf Köhler

Malignant processes in the intestinal tube are always of interest — those appearing in the large intestine on account of their fairly great frequency, those in the small intestine because of their infrequency. SHALLOW *et al.* (7) very appropriately say that primary malignant tumours in the small intestine are a challenge to modern surgery on account of their infrequency, the difficulty in diagnosing them at an early stage. Also, they demand great technical skill, the operation mortality is great and the prognosis grave.

About twenty years ago the diagnosis of tumours in the small intestine was very rarely made with the aid of roentgen examination, although the pioneers in gastro-intestinal roentgenology were quite clear as to the translation of roentgenologic data into terms of pathologic anatomy. The main principles in carrying out the examination have not been changed to any extent since that day — yet, not until FORSSELL aroused interest in mucosal fold studies, have better results been obtained.

The local roentgenologic changes regrettably appear at a late stage of the disease and similarly, on the whole, the clinical symptoms. Already in 1926 HELLMER (4) wrote »die direkten Symptome (= the local symptoms mentioned) in den Dünndärmen leider keine Frühsymptome sind, sondern werden im allgemeinen erst registriert nachdem sich die indirekten (= symptoms of stenosis) bereits eingestellt haben».

The most detailed work in Scandinavian literature on tumours of the small intestine has been published by ÅKERLUND, 1932 (11). He states that local changes of a kind permitting definite preoperative diagnosis of the tumour have exceedingly rarely been found in the picture of the

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small intestine. In general there is no possibility of making a roentgen-diagnosis until the tumour has brought about such a marked stenosis that a picture of ileus of the small intestine is present.

He points out as well that »es wohl möglich ist eine röntgenologische Lokaldiagnose auf Dünndarmtumor zu stellen und zwar lange bevor ein ausgebildeter Ileus vorliegt. Voraussetzung ist eine sorgfältige Untersuchungstechnik und ein genaues Studium des ganzen Schleimautreliefs des Dünndarms in einen frühen Stadium bevor ausgesprochene Obstruktionssymptome vorliegen.» ÅKERLUND also points out facts supporting this statement, viz. four cases of tumours in the small intestine preoperatively diagnosed with the aid of roentgen rays.

Since the beginning of the nineteen-thirties there has been great interest among Americans in the use of roentgenological methods for diagnosing lesions in the small intestine. Numerous papers from various quarters containing an imposing collection of cases diagnosed with roentgen-rays give evidence, and results have been obtained. The diagnostic exactitude has increased greatly and now approaches that of ventricle-colon-examinations.

Incidence

Primary malignancy of the small intestine occurs in 0.1 per cent in a general series of post-mortem examinations while that of the large intestine is 3.6 per cent. These figures are quoted from a series of more than 137,000 cases collected from various countries. Among 6,273 cases of intestinal carcinoma there were 182 cases of cancer of the small intestine — 2.9 per cent. The corresponding figures for sarcoma are 984 and 598, *i. e.* 60.7 per cent of the intestinal sarcomata were situated in the small intestine (7).

SHALLOW *et al.* have also collected 269 cases of primary malignant tumours of the small intestine stated at operation. This material makes clear, that carcinomata are about twice as common as are sarcomata, the former dominate in the upper parts of the small intestine, the later in the lower parts.

To give an idea of the relation between malignant and benign tumours in the small intestine it may be mentioned that 108 malignant cases were diagnosed at the Mayo Clinic in 1907 to 1939, while the number of benign tumours was only 41 (10).

Symptoms and clinical findings

The clinical picture is variable: disorders due to stenosis, generally gradual in the onset, indefinite pains, pressure feelings below the chest

and a sensation of over-fullness, and later vomiting. The symptoms may, however, appear rapidly and resemble those of ileus. The neoplasms are palpable before the diagnosis is made but this is not always the case. They are often small and meteorism renders palpation more difficult.

Blood in the stools is a sign that should be watched and if the ventricle and the colon do not show pathologic changes special attention should be given the intermediate part of the intestinal tube. Secondary anaemia occurs frequently.

Pathology

SWENSON (8) divides the malignant tumours in the small intestine by their gross morphology into three types:

1) The constricting
2) The fungating
3) The diffusely infiltrating.

The first type is generally annular. It is as a rule sharply demarcated and causes a diminution of the lumen in connection with which a mechanical obstruction arises.

The second type produces a fungating or polypoid mass which forces its way towards the lumen. At a fairly late stage it attacks all layers of the intestine but does not cause an obstruction until the tumour is quite large in size.

Ulceration and destruction of the mucosa is quite common in these two types and are generally caused by an adenocarcinoma.

The third type is characterized by a diffuse infiltration which thickens the wall of the intestine and attacks one fairly long segment, or even several. The mucosa is generally intact for a long time. Diffuse lymphosarcoma is generally a representative of this type.

Roentgenological diagnosis

If there are clinical signs of obstruction the diagnosis of ileus can be established by a finding of dilated bowels and fluid levels on films taken with horizontal radiation, the patient being in lateral or upright position. It may, however, be advantageous to administer small doses of contrast by mouth as that is not in the present day considered injurious in any way (2).

In certain quarters in America Miller-Abbot's tube is frequently used for close study of the region of stenosis. This is a double lumen tube with a small balloon-shaped distention at the point.

It is carried along with the functions of the bowels toward a possible area with stenosis. Through one of the lumens gas and fluid may be

drawn for therapeutical purposes, through the second one small amounts of contrast may be injected. With this method the superimposed shadows of surrounding or overlying bariumfilled loops can be avoided, thereby bringing even a fairly insignificant lesion into profile.

If no counterindications are present a pure mixture of barium sulfate in water is administered orally, in the proportion Ba to water, about 3 : 4. In some quarters the whole amount, 2—400 ml. in one dose is given, other physicians again prefer to let the patient drink the amount in two, ore more portions with an interval of one to two minutes.

The main point is to observe the penetration of the contrast with the aid of numerous screenings, particularly during the first hour. Frequent identification and location of the lesion is greatly due to the care taken by the examiner in studying each separate segment. The pattern of the entire small intestine should be elaborately watched. This was pointed out already by ÅKERLUND and is further stressed by roentgenologists of the Mayo Clinic. The work requires much time and concentration.

Besides screenings, exposures are of course made, particularly in the beginning of the examination. These are generally made in prone position but also other positions may be indicated. The ileum is most difficult to examine. The coils are situated low down and have a tendency to form one single agglomeration. The lowest part is often brought out best by contrast enema being thrown through the valvula Bauhini into the terminal ileum.

The roentgenolgist's main task is to state the presence or absence of a lesion and to locate it. Proceeding from roentgenologic characteristics he shall endeavour to give the lesion a histologic denomination — a task which he does not always, by far, succeed with (3).

WEBER and KIRKLIN (10) say »like colon the small intestine is a tubular organ. These divisions of the alimentary tract resemble each other in every important morphologic and physiologic respect. The pathologic processes which occur in them are similar and both divisions are deformed by such processes in similar ways. Hence it is possible to apply the same roentgenologic criteria of diagnosis to the small intestine as have been found reliable in the diagnosis of the normal and abnormal large intestine.»

The deformity or »filling defect» produced by a tumefactive lesion may be marginal, encircling or central. An analysis of the morphologic features of this deformity often leads to an accurate estimation of the histologic type (3). The constricting and polypoid malignant tumours cause, if they are small, such a »filling defect». In more advanced cases there is an obstruction and sometimes the tumour may bring about an invagination. In obstructions the histologic diagnosis is rarely successful and if there is an invagination it is practically never so. The diffusely infiltrating

ype of tumour which generally affects long stretches of the intestine is xtremely difficult to differentiate from non-neoplastic tumefactions, rincipally tuberculosis and non-specific enteritis.

Signs of malignancy are as follows:

1) Obliteration of the folds of the mucous membrane in the entire length of the lesion which shows rough, jagged contours.
2) The channel through the malignant process is often eccentric opposite to the same through an inflammatory lesion that is concentric with the lumen of the uninvolved segments of the bowel.
3) The deformity is short, sharply deliminated, and marginal or circular.
4) The affected segment is stiff, moves in its entirety when shifted, is often sensitive to pressure, and resistance is felt.

The following roentgenologically diagnosed primary malignant tumours in the small intestine I have found in the literature of Scandinavia:

HELLMER (4) describes the find in a woman, forty-six years of age, who was losing in weight. At roentgen examination a stricture, 9 cm. in length, with spotted rarefactions was found 85 cm. from the flexura duodeno-jejunalis. On the oral side of the stricture the intestine was greatly distended, the passage retarded. On operation a papillomatous carcinoma was found.

HELLSTRÖM (5) presents a case, a woman aged fifty-four, who had colicky pains and flatulence, she vomited and showed signs of losing in weight. The roentgen examination revealed a constriction of the lumen about 10 cm. from the flexura duodeno-jejunalis. On operation a carcinoma with ring-shaped depression on the outer side of the intestine.

ÅKERLUND (11) reports a find in a woman, aged fifty-eight, with melaena and anaemia in which the ventricle and the colon showed nothing pathologic at two different examinations. On passage examination of the small intestine an area of the size of a plum was found 20—25 cm. from the flexura duodeno-jejunalis. In this area the normal mucous folds had disappeared completely. An irregular defect, surrounded by a wall, was observed. It corresponded to a slightly tender resistance. At the operation the roentgen finding was observed to be caused by a haemangiosarcoma.

FLEMMING MÖLLER (1) mentions a case that showed a sharply delimited tumour defect in duodenum. There were no signs of infiltration in the wall of the intestine in the region of the defect. Three years later the defect had changed somewhat, suggesting carcinoma. The patient died soon after and at post mortem examination Ca-colloides was stated. In this connection FLEMMING MÖLLER discusses the possibility of a benign tumour becoming malignant or — had the defect been malignant already in the first examination.

TORGERSEN (9) has diagnosed an adenomatous carcinoma in a thirty-

Fig. 1. Examination of ventricle, supine position. Flexura duodeno-jejunalis well filled with contrast. Arrow = region of stricture.

Fig. 2. The resected specimen, partly opened. The nodose tumour is visible in the place marked with an arrow.

eight-year-old man with anaemia and occult haemorrhage for several months. In the flexura duodeno-jejunalis there was a niche with stiff contours, the size of a walnut. At the operation a deep constriction as if made by a thread was observed on the outer side of the intestine, similarly as in HELLSTRÖM's case.

SCHMITH and THYSSEN (6) report two cases of carcinoma in the small intestine, both preoperatively verified by roentgen examination, and situated about 10 to 20 cm. from the flexura duodeno-jejunalis with stenosis.

Both patients suffered from anaemia and occult haemorrhage.

Case report

A woman, aged seventy-one, had been troubled with rumbling sounds in her abdomen, belching, and mild pains in the region of the navel for two to three weeks. Her general condition was exceptionally good. S. R. 19 mm. in one hour. Hgb. 62 per cent, no blood in the stools. In roentgen examination of the stomach no pathologic changes were observed. About 15 cm. in distal direction of the flexura duodeno-jejunalis a marked constriction of the lumen was observed. It formed an eccentric, somewhat irregular channel, 5 cm. in length and about 0.5 cm. in width. On the oral side of the constriction the intestine was considerably dilated. (Fig. 1.) On palpation a slightly tender, mobile resistance of the size of a small hen's egg was found corresponding to the constricted part. At the operation a tumour with a deep circular constriction on the outer side of the bowel — corresponding to the roentgenolgic constriction — was found in the mentioned place. A part of the intestine of adequate length was resected (Fig. 2) and the extirpated lymph glands were found to be intact. The Path. Report showed adenocarcinoma. Eighteen months after the surgical intervention the patient's general condition was good, the passage through the intestine was normal and there were no signs of malignancy.

SUMMARY

Primary malignant tumours of the small intestine are infrequent but should be taken into account in indistinct abdominal cases. There are no characteristic symptoms. Roentgen examination gives the most reliable pre-operative diagnosis but the examination requires minute and careful study of each separate section of the intestine. The following signs of malignancy are consistent: Obliteration of the folds of the mucous membrane along the entire trend of the lesion which is short, sharply demarcated, stiff, and whose lumen is eccentric. A case of roentgenolgically diagnosed carcinoma of the jejunum is described.

ZUSAMMENFASSUNG

Primäre bösartige Dünndarmtumoren sind selten, doch darf man sie bei unklaren Bauchfällen nicht vergessen. Die Symptome sind uncharakteristisch. Röntgenuntersuchung gibt die beste preoperative Diagnose aber der Untersucher muss sehr sorgfältig jeden einzelnen Darmabschnitt studieren. Die sichersten Bösartigkeitszeichen sind: Die Schleimhautfalten sind im ganzen Tumorgebiet, welches kurz, steif und scharf begrenzt ist und ein exzentrisches Lumen hat, verstrichen. Ein röntgendiagnostisierter Fall von Jejunumcarcinom wird beschrieben.

RÉSUMÉ

Les tumeurs malignes primaires d'intestin grêle sont rares mais doivent être considérées dans les cas d'abdomen incertains. Elles ne donnent pas de symptômes caractéristiques. L'examen radiologique donne le meilleur diagnostic pre-opératoire mais chaque

partie de l'intestin grêle doit être examiné avec attention. Voici les indices les plus certains des cas malignes: Les plis de la muqueuse sont effacés tout le long de la lésion qui est courte, rigide et distinctement limitée et dont la lumière est excentrique. Un cas de cancer de jejunum diagnostiqué aux rayons roentgen est relaté.

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FROM THE ROENTGEN CLINIC OF THE CENTRAL HOSPITAL FOR FREDERIKSBORG COUNTY, HILLERØD, DENMARK (CHIEF: SVEND A. CHROM, M. D.)

ON TOMOGRAPHY AS AN ADJUNCT TO UROGRAPHY[1]

by

Preben Thestrup Andersen

Since July 1947, we have in the radiologic service of the Central Hospital for Frederiksborg County used tomography of the kidney region as supplement to the usual urography, in order to obtain more distinct nephropyelograms free from the disturbing shadows often caused by the presence of feces and gas in the intestinal tract.

Tomography has long ago proved its value in pulmonary diagnosis, where it is much used. In other fields of roentgenologic diagnosis it has seldom been employed. Therefore, it was of the greatest interest that WEINBREN (1) in his richly illustrated »Manual of Tomography», published in 1946, showed how this method of examination may be used with advantage in nearly all fields of roentgenologic diagnosis. Moreover, the book contains an excellent technical guide to the practice of tomography.

Owing to the location of the kidneys close up against the muscles of the posterior wall of the abdomen, on a level with the lower thoracic and upper lumbar vertebrae, the ordinary roentgenograms are often veiled by gas-filled loops of intestine or accumulations of feces, so that the shadows from the nephropyelograms are blurred or even completely covered; thus making all diagnosis impossible. The fecal masses can as a rule be removed by preceding bowel preparation by means of laxatives or enemas. This can be done systematically in a hospital service, but in the case of out-door patients it will often be difficult to obtain a satisfactory evacuation, and, in consequence, the conditions for the work of the radiologist will be less favorable; while, on the other hand, postponement of the examination will also mean additional expense and waste of time for the patient. In another category of cases — the acute — preparatory bowel preparation will be out of the question, and the estimation of the picture may be so difficult that one simply has to give

[1] Submitted for publication, May 15, 1948.

up the attempt either to confirm or to negative a diagnosis. Also the gas in the intestine may be a great hindrance. In renal colic, for instance, the accumulation may be so great that the case may look like an ileus. It has been tried to reduce the gas content by preparatory administration of medicaments stimulating the peristalsis. Thus, SCHEIBEL (2) reported in 1932, in the Acta Radiologica, a number of cases in which he by administration of pitressin half an hour before the examination had been able to reduce the gas content so much that conditions for establishing the diagnosis became considerably better. From the United States a similar procedure was reported by WEBB (3) in 1945. He, too, administered pitressin, an hour before the examination, and found that the gas in the intestine diminished considerably, though he did not succeed in getting it removed altogether. In his paper, he also mentions the inhibiting action of the pitressin on the diuresis and the resulting concentration of the contrast substance in the urine, which should have the effect of increasing the intensity of the shadows.

Under impression of the rather considerable number of cases in which we, owing to the above-named circumstances, had to postpone the urographic examination of patients for whom such postponement entailed an increased number of sick-days and resulting loss of wages, we have, as said, in the last year or so routinely practised tomography of the kidney regions as an addition to all our urographic examinations, in order to get around the obscuring shadow formations in the intestine and thus obtain a more distinct nephropyelogram. The value of tomography in cases of this category is briefly mentioned in WEINBREN's manual and illustrated by some excellent examples, otherwise the literature on the subject is scant. In a paper by PENDERGRASS (4) from 1943, on urography as test of the renal function, it is merely stated that urographic tomograms may disclose conditions in the kidneys that can not be seen in routine films, and WILHELM (5) has in 1943 shown that tomography in association with perineal insufflation may help to make the diagnosis of pathologic changes in the adrenals more certain.

Technic

The technic employed in the cases referred to in the present paper is, as already said, a combination of urography with tomography of the kidney regions. In taking the tomograms, we have followed the method indicated by WEINBREN. The patients were prepared for the examination in the usual way, with thorough evacuation of the intestinal tract and diminished supply of fluids from the evening before until the investigation is terminated. There was no preparatory administration of medicaments in order to reduce the contents of the intestine. The patient

s placed in supine position on the Bucky table, and a routine roentgenogram is taken over the renal and urinary passages. When the picture has been passed upon, the contrast fluid is injected intravenously. In most of our cases we have used hippodine in 50 per cent solution, only in a very few cases other preparations, for instance a 75 per cent solution of uropac. Except in one case, in which the patient was a child seven years old, the amount injected was invariably the same: 20 milliliters. All our pictures were taken without compression, because our apparatus for the latter could not be mounted on the Bucky table together with the tomograph.

Ten minutes after the injection of the contrast medium, a second routine roentgenogram is taken of the renal and urinary area, and immediately afterwards a tomogram of both kidney regions simultaneously. For this exposure, the patient's knees and hips are strongly flected in order to flatten out the lumbar region as much as possible. Thus the sagittal plane through the kidneys will be parallel with the table top, and it will therefore be possible to estimate with greater certainty at what depth, from the table top upwards, the tomogram has been taken. This depth will in the case of adult subjects as a rule be between 5 and 10 cm. In most of our cases it has been between 6 and 8 cm.

The view we have tried to obtain is one through the middle of the kidneys, like an anatomical section. A certain measure for whether the tomogram has been taken too centrally or too peripherally may be had by considering its relation to the spine. In tomograms taken too peripherally, the transverse processes and the lower ribs will show up distinctly; in tomograms taken too centrally, structures corresponding to the middle of the vertebral bodies will be seen. With an anatomically normal spine, the relation of the latter should correspond to the posterior half of the vertebral bodies and their point of junction with the roots of the vertebral arches. If there are any deformities in the spine, these estimates will not hold good, of course, and it will therefore be necessary to take views in different planes in order to obtain the optimal result. This estimation of the proper situation of the plane in relation to the spine has been of great value, because the present scarcity of films has greatly restricted the number that could be afforded for these examinations. With an unlimited number of films at one's disposal, one need only take as many tomograms as necessary in order to obtain the optimal view. The centering has been done to a point midway between the xiphoid process and the umbilicus.

The views were in nearly all cases taken on 24 × 30 cm. films. This is also the size used by WEINBREN, and it has the advantage that the views of both kidney regions are taken on the same film. It is a question, though, if this size of films is not too large for tomography. GROSSMANN

(6), for instance, recommends to use a smaller size, not over 18 × 24 cm. This also makes the centering more exact, as each kidney region must be tomographed separately. Twenty minutes after the injection one again takes the same two pictures; routine roentgenogram and tomogram of the kidney regions. In the cases where the excretion was particularly slow, we have taken pictures an hour after the injection, or, if necessary, later.

Author's Material

As said, we have used the method here outlined in the examination of all our urographed patients. We have analysed the result of the first 100 examinations, in order to get an impression of the value of tomography as a help to obtain more distinct nephropyelograms.

Case Histories

The first example is taken from the group of acute cases. The patient was a man aged forty-eight (1924/47), who had been admitted to the surgical ward of the Central Hospital for Frederiksborg County with the diagnosis of perforating gastric ulcer. Except for some complaints about slight dyspeptic troubles in the last couple of years, he had been perfectly well until a month before admission. Then he suddenly got a severe attack of pain in the abdomen, lasting five or six hours, a little to the left of the umbilicus and up under the right thoracic margin. The attack ceased spontaneously, but two and a half hours before admission he got another, similar one, only much more acute. There was no radiation of the pain, but nausea and three or four vomitings. When admitted, he was in great pain and complained of tenderness in the whole left side of the abdomen, especially at the level of the umbilicus. As microscopy of the urine showed positive erythrocytes, urography was done in addition to the usual routine roentgenography of the abdomen. The routine films, both those taken with the patient standing and lying down, showed numerous gas-distended loops of intestine: no fluid level. No signs of free gas, no concrement shadows. A 75 per cent solution of uropac was injected, and five minutes later first a routine roentgenogram over the kidneys and urinary passages (Fig. 1 a) was taken, and immediately afterwards a tomogram (Fig. 1 b) of the kidney regions at a depth of 8 cm. As expected, the routine view did not show anything of the kidney shadows; neither was it possible to determine whether there was any excretion in the efferent urinary passages. In the tomogram, one clearly sees not only the shadows of both kidneys, but also the calyces, the pelves and the beginning of the ureters. These

Fig. 1 a.

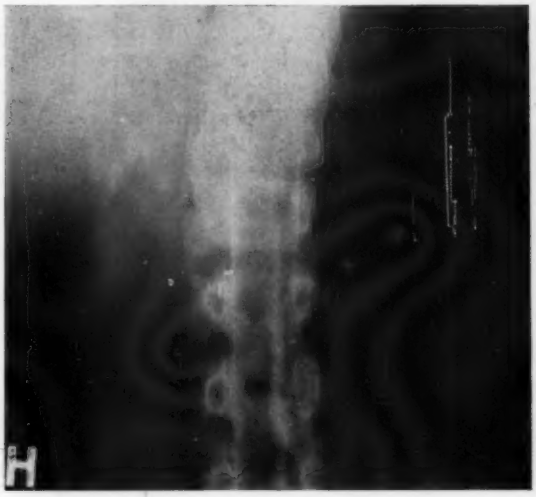

Fig. 1 b.

are normal, without signs of either dilatation or concrement shadows. A second tomogram, taken ten minutes after the injection, showed identical conditions. The roentgenologic diagnosis was meteorism, and the subsequent surgical operation showed that it was a case of occlusive ileus.

This case shows the value of tomography in acute cases. Here, where there is no time for bowel preparation of the patient, ordinary urography does not suffice. The kidney shadows and the excretion in the efferent urinary passages are completely obscured, whereas one by means of the tomography gets a nephropyelogram which enables one to establish the diagnosis: nothing abnormal.

The next example is the case of a woman aged fifty-one (1191/47) admitted to the medical ward of the Central Hospital suffering from angina pectoris, neurasthenia and chronic obstipation. When a child she was said to have had an attack of renal calculus. She complained of diverse troubles, partly of cardiac, partly of dyspeptic character. Objective examination showed hypertension: 170/120, no albumin or sugar in the urine. Microscopy of the urine, nothing abnormal. On urography (Fig. 2 a), large accumulations of feces and gas were seen to obscure the pyelogram, so that the finer details could not be distinguished. In a tomogram taken at a depth of 6 cm. (Fig. 2 b) a considerably clearer view was ob-

Fig. 2 a.

Fig. 2 b.

tained of the more delicate structures in the pyelogram. The right side was seen most distinctly, whereas the median calyces on the left side were not demonstrated, no doubt owing to the difference in the position of the two kidneys. The value of the tomogram in this case is evident. A refractory obstipation made evacuation of the patient's bowels difficult; the routine urogram only showed that there was excretion on both sides, both threw light on the nephrograms and demonstrated the finer details in the pyelograms.

The third example is taken from the prostatic hypertrophy group. The patient was a man aged seventy-two (2065/47) admitted to the surgical ward of the Central Hospital for Frederiksborg County in November—December 1947 with a history of increasing pollakiuria of fifteen years' standing, two years ago complete retention, for about nine months prior to admission intermittent hematuria. Cystoscopy showed moderate bleeding from the fundus of the bladder, but no marked hypertrophy of the median lobe of the prostate, which on exploration was felt to be considerably enlarged and of firm, elastic consistence. No albumin or sugar in the urine. Urography (Fig. 3 a) showed considerable collection of gas in the loops of the small intestine upwards and to the right in the abdomen, making interpretation of the routine nephrograms difficult; but a tomogram taken at a depth of 9 cm. (Fig. 3 b) gave a distinct

Fig. 3 a.

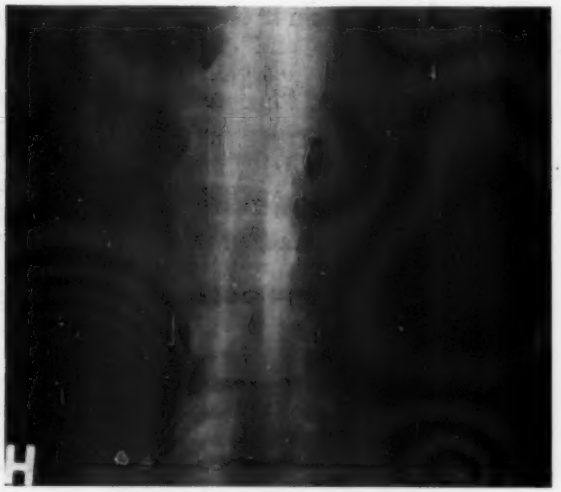

Fig. 3 b.

picture of both kidney shadows, showing them to be of normal shape and in normal position. The pyelograms, which in the routine roentgenograms were badly obscured, appeared normal, without any evidence of stasis. The advantage of tomography in this case is, among other things, that the nephrogram obtained is so clear that the state of the renal parenchyma can be judged with much greater certainty. Moreover, it shows up the calyces and pelves, which in the routine films were obscured by the gas in the intestine.

The next two cases show the value of tomography in pathologic cases in which neither urography nor direct pyelography has yielded any information on which a diagnosis might be based.

The first is that of a man aged twenty-nine (1928/47), who had been admitted to the surgical ward of the Central Hospital with the diagnosis of right-side pyonephrosis and vas aberrans. Except for some slight laryngitis two—three times every winter, he had formerly in the main been well, but in the last two years he had had a feeling of extrasystoles in the precordium, and since 1938 he had at times, especially after any physical effort, suffered from pains in the right lumbar region, which were interpreted as lumbago. In the last six weeks before admission he had been subfebrile, with temperature about 38° C., a single

time rising to 39°. Otherwise there had been no subjective symptoms, particularly none referable to the kidneys or the urinary passages. There was albumin in the urine, but no sugar. Microscopy of the urine showed leukocytes and erythrocytes. Blood urea 38. Blood pressure 140/90. Esbach 0.6/0.8 gm. Tb. test of the urine negative. In connexion with urography, tomograms were taken at a depth of 6 to 7.5 cm. Only in the tomograms could it be seen that the right kidney was distinctly reduced in size, with an uneven, knobby surface. Excretion was demonstrated only in a couple of pocket-like formations in the inferior part, undoubtedly corresponding to the bottom of a much dilated renal pelvis. The tomograms of the left kidney showed normal conditions. On the routine films, both kidneys were completely obscured by intestinal contents, so that the feeble nephrograms and the slight excretion on the right side were completely blotted out and no exact diagnosis possible. Direct pyelography could not be carried out. After a couple of millimeters of contrast fluid had been injected on the right side, the patient complained of severe pain in the region of the right kidney, and the injection had to be discontinued. On films taken immediately afterwards it was seen that the ureter was only filled as far as to the point of the inserted ureteral catheter. At the subsequent surgical operation it was found that the right kidney was the seat of considerable changes. The surface was very buckled, the parenchymal border very thin, there was rather considerable pyonephrosis. The pelvis was distended almost to the size of a goose's egg. The ureter started sloping downwards and then made a looping detour inwards to the under side of the renal pelvis, to which it was fibrously connected and thus cut off. These changes were probably due to aberration of a vessel from the inferior end of the kidney.

The next case in this group is that of a man aged thirty-eight years (19/48), who was a patient in the surgical ward of the Central Hospital from Nov. 11th, 1947, to Jan. 7th, 1948, with the diagnosis of high-grade right-side hydronephrosis and chronic fibroplastic periorchitis, and under observation for bronchiectasis. In the main, he had formerly been well, but in the last four or five years he had periodical attacks of pain in the right lumbar region, radiating down towards the symphysis. No pollakiuria, dysuria or hematuria. Never observed any passage of calculi. Six weeks before admission he had felt a pain in the right groin, radiating down towards the right half of the scrotum, where he had noticed a lump. On Nov. 5th he had been operated upon, a right-side hemicastration being performed. The microscopy showed no evidence of tuberculosis or malignancy. As the attacks of pain in the lumbar region persisted, a urographic examination was made. The routine films taken over the kidney- and urinary passages showed considerable gas in the intestine

and some accumulations of feces. After intravenous injection of contrast fluid, distinct pyelograms were seen only in the tomograms taken at a depth of 8 cm., whereas in the routine roentgenograms no details could be distinguished on either side. The tomograms showed the right kidney distinctly diminished in size and with an uneven, knobby surface. Besides, there was seen a slight secretion of contrast substance in some large roundish, sac-like cavities, so that it must be supposed that the calyces and pelves were much dilated, with resulting narrowing of the parenchymal layer. The left pyelogram showed nothing abnormal. Also the nephrogram appeared normal. Direct pyelography on the right side proved impossible. The contrast fluid encountered an obstruction at the point where the ureter entered the pelvis, and flowed down along the ureteral catheter, none of it passing into the renal pelvis. The pyelogram on the left side was normal. At the subsequent surgical operation it was found that the right kidney was very small, the parenchyma very thin, the hydronephrosis as large as a clenched fist. The ureter began at a point somewhat away from the center of the inferior pole of the kidney, perhaps owing to to an aberrant vessel there. On section of the kidney, an enormously distended pelvis was seen, continuing out into correspondingly distended calyces. The connective tissue of the kidney itself was reduced to a thin shell. The pelvic mucosa was smooth. There were no signs of disintegration cavities. The surface of the kidney was knobby.

In both these cases, the accumulation of gas in the intestines of the patients obscured the kidney regions so badly that no diagnosis could be made on the basis of the routine roentgenograms. The tomograms eliminated this obstacle and clearly showed both the state of the parenchyma and the conditions as regards the excretion in the pathologic renal pelves. One of the greatest values of the method becomes apparent here, since the tomograph enables us to obtain pyelograms on which the diagnosis may be based, even if the excretion in the efferent urinary passages is only slight. Besides, there was in these two cases the special circumstance that direct pyelography could not be carried out; therefore the information obtained by means of the tomograms became of the greatest value as indication for the surgical operation — we may say, in fact, the only solid basis for the roentgenologic diagnosis.

As illustration of a particular feature of the tomographic urogram — namely the nephrogram — I shall finally mention the case of a woman aged sixty-three (1161/47) who had been admitted to the medical ward of the Central Hospital for observation of an affection of the kidneys, but on closer investigation it was found that she was suffering from osteomyelitis of the spine. Owing to the diagnosis under which she had been admitted, a urographic examination was made as a matter of routine.

Fig. 4.

The tomograms (Fig. 4) showed both the nephrograms standing out very clearly in contrast to the surrounding tissue, giving a good idea of the outlines of the kidneys and the breadth of the parenchyma.

The first 100 urographies done by the roentgen clinic were taken up for critical analysis in order to get an impression of the extent to which tomography might be of help as an adjunct to urography. In a general way it may be said that the tomographic urograms are a valuable supplement to the routine examinations, because they in most cases enable one to get a clear picture both of the renal tissue and of the efferent urinary passages. The elimination of the obscuring gas and feces in the intestine, no matter how great their accumulation, was in all cases complete. As an example, I may cite an instance where a patient by mistake was sent for direct pyelographic examination the day after he had been in for examination of his stomach. The routine roentgenogram showed a completely contrast-filled colon. The points of the two ureteral catheters lay corresponding to the contrast substance in the transverse colon. Attempts to get routine views in the usual manner gave an absolutely negative result, but with the aid of the tomograph the hindrance presented by the contrast fluid in the colon was completely overcome, and we obtained perfectly serviceable pyelograms.

The nephrogram, whose appearance in the film depends on an intensification of the soft tissue shadows determined by the amount of contrast substance in the vessels and tubules, was very clearly demonstrated in all the tomograms, standing out in sharp contrast to both the perineal

and the perihilar tissue. This made it possible to judge about the thickness of the parenchyma and the form of the surfaces of the kidneys. By that, the tomography absolutely helps to make the diagnosis of the state of the renal parenchyma more certain, because the nephrogram even under optimal conditions very often is poorly demonstrated in the routine films, where it will always be more or less obscured by the overlying viscera, even when these are empty. It only requires a small amount of contrast substance accumulated in the vessels and tubules to make the shadows sufficiently dense to enable one to form a diagnostic estimate.

The density of the shadows of the calyces, the pelves and the beginning of the ureters has varied somewhat in the different tomograms, because it, owing to the different location of these structures, has not been possible to get them demonstrated distinctly in a single plane. This difficulty has been particularly marked in the cases where the kidneys were situated with the hilus turning very much forwards; but, as said, this difficulty can be overcome by taking a series of tomograms in different planes through the kidneys.

To sum up, the tomography will be of help for the diagnosis

1) in cases where bowel preparation cannot be undertaken and the amount of gas in the intestine is abnormally increased;
2) in out-door cases where the evacuation of the patient's bowel is incomplete, and in the case of ward patients where evacuation is difficult to obtain;
3) in cases where the patient is suffering from prostatic hypertrophy; a condition which, as we know, is often associated with marked flatulence;
4) by making it possible to obtain a more distinct nephrogram.

SUMMARY

The author gives the results of an analysis of 100 urographies in which the routine examination was supplemented by tomography of the kidney regions. He finds the tomographic method a valuable adjunct, particularly in acute cases, out-door cases and cases where the patient is suffering from prostatic hypertrophy. He specially calls attention to the distinctness of the nephrogram.

ZUSAMMENFASSUNG

Verf. bringt die Ergebnisse einer Analyse von 100 Urographien, bei denen die routinenmässige Untersuchung mit einer Tomographie der Nierenregion vervollständigt wurde. Er findet, dass die Tomographie eine wertvolles Unterstützungsmittel darstellt, besonders bei akuten Fällen, ambulanten Fällen und Fällen mit Prostatahypertrophie. Er macht besonders auf die Deutlichkeit des Nephrogramms aufmerksam.

RÉSUMÉ

L'auteur apporte les résultats de l'analyse de 100 urographies où l'examen ordinaire fut complété par la tomographie des régions rénales. Il trouve la méthode tomographique un adjuvant précieux, en particulier dans les cas aigus, les cas policliniques et ceux où le malade souffre d'hypertrophie prostatique. Il attire spécialement l'attention sur la clarté des images rénales.

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FROM THE ROENTGEN-DIAGNOSTIC DEPARTMENT OF SAHLGRENSKA HOSPITAL, GOTHENBURG, SWEDEN (CHIEF: GÖSTA RUNSTRÖM, M. D.)

AN APPARATUS FOR THE DETERMINATION OF THE AXIAL LENGTH OF THE EYEBALL[1]

by

Harry Larsson

With the apparatus for locating intra-orbital foreign bodies described by H. LARSSON in Acta Radiologica, vol. XXII, page 704, 1941, the distance of the foreign body from the centre of the eyeball is determined. Its distance from the top of the cornea can also be determined by a calculation method described by S. STENSTRÖM in Acta Radiologica, page 339, 1945. As the eyeball is not the same size in all persons it is not possible, in those cases where measurement indicates that the foreign body ought to be situated in or close to the wall of the eyeball in an eye of normal size with a radius of 12.5 mm., to determine whether the foreign body is in or outside the eyeball merely by calculating its distance from the centre of the eyeball or the top of the cornea. It is also essential, for this purpose, to know the size of the eyeball.

In principle, there are several different methods for determining the size of the eyeball.

I. An indirect method based on the principle of determining the refracting force of the refracting media and calculating the length. This method is unreliable and not suitable for practical clinical use.

II. Direct measurement of the width of the eye in the equatorial plane with a pair of compasses by a method described by BERG. The rounded-off tips of a specially constructed compass are introduced into the conjunctival sac while the eyelids are held apart. All eyes are not capable of being measured in this way, however, as the conjunctival sac is not sufficiently deep in some persons. The diameter in the equatorial plane is said to vary between 19 and 28 mm. The margins for error are estimated to be about 0.5 mm. This method gives no information regarding the length of the eye, however.

III. The length of the eye can be determined after its posterior pole

[1] Submitted for publication, March 23, 1948.

has been outlined with a contrast medium. SPECCIALE-PICCICHE described in 1927 two cases in which lipiodol was introduced into the spatium tenoni for the purpose of locating the wall of the eyeball in relation to a foreign body. In the one case he demonstrated that the foreign body was in the eyeball and in the other that it was outside the eyeball. STAUNIG and HERRENSCHWAND published a report in the same year on animal experiments; in these they injected air into the spatium tenoni in order to outline the eyeball. SANDERA and GEISLER, in 1930, used iodipin and air for the same purpose. They considered that the eyeball could then be more clearly distinguished than when air alone was used. In 1935, FARBEROW and MEDVEDEW described 15 cases in which they had injected lipiodol or iodipin into the spatium tenoni. In five of these cases the eyeball was either not outlined at all, or only very partially so. In the other 10 cases the outline was good. They maintained that, in practice, it is difficult to inject the contrast medium into the spatium. The substance should be injected under one of the rectus muscles while the muscle is held uplifted by pincers in order to widen the spatium. Lipiodol and iodipin are absorbed slowly, and remains of the substance were to be seen for as long as two months after the injection. SUJODOSC has demonstrated in animal experiments that sodium iodide and lipiodol are not suitable for injection into the spatium tenoni as they cause damage visible under the microscope. Lipiodol and iodipin also have the added disadvantage of being capable of concealing a foreign body, and if an attempt at localization fails it cannot be done over again because of the slow rate of absorption. According to SUJODOSC, injection of air into the spatium caused no histologically observable changes. He considered, however, that there was a slight risk of air embolism, and he preferred to use a positive contrast medium (sergosin).

Some of the methods suggested for determining the length of the eye have been tested on the department of diagnostic radiology in cooperation with the department of ophthalmology at Sahlgren's Hospital. A contrast medium was injected into the spatium in only a very few cases. In the cases where this was done, perabrodil was found to cause slight subjective discomfort but outlined the eyeball well. In those cases where air was injected, we used, to begin with, 5—6 cc. of air, but this sometimes caused the walls of the spatium to burst and the air became concentrated below the conjunctiva. About 2 cc. of air was found to be the best amount to use. The posterior part of the eyeball was outlined well with this quantity. As this method seemed to involve some risk of air embolism, as well as the risk that infection might spread from perforating eye wounds, it was abandoned.

IV. Another method of determining the length of the eyeball is based on the principle that roentgen rays stimulate the retina.

ROENTGEN himself thought, to begin with, that the rays he had discovered were invisible. He had, in November 1895, obtained a faint retinal image in the dark when working with a Hittorf tube, but he did not at first connect this observation with the roentgen ray radiation since he did not observe the phenomenon again in other similar experiments. This was due to the fact that he was then working with tubes giving softer rays. As early as 1897, however, he reported that all tubes giving hard radiation produced a retinal image in an adapted eye. He also observed that if a beam of rays that had passed through a very narrow slit struck the eye, different retinal images were formed according to the part of the eye that was struck. This observation was later confirmed in 1901 by CRZELLITZER, among others. He maintained that the method could be of use in function tests on the retina and for locating pathologic changes in the retina.

According to GODFREY, SCHENK and SILCOX, both the rods and the cones in the retina are sensitive to roentgen ray radiation. In the dark, the adaptation curves have the same appearance both for ordinary light and for roentgen rays. These authors give the threshold value for the occurrence of visual perception, in roentgen ray radiation of the retina, as $^1/_2$ r per second to each cm^2 of the retina.

Working on the basis of this phenomenon, RUSHTON, in 1938, worked out a method for measuring the length of the eyeball. His experiments were carried out in the following manner. Through a narrow slit attached to a roentgen ray tube the roentgen rays were made to strike through the eyeball from the side, at right angles to its axis. The position of the top of the cornea could be determined at the same time by means of a beam of ordinary light parallel to the roentgen ray beam and a microscope fitted with a graticule. The beam of light and the microscope could be moved until the cross wires of the microscope were seen to touch the top of the cornea. The position of the top of the cornea was then known. The person examined had a visual perception in the form of a blue-green ring corresponding to the narrow, ring-shaped area of the retina struck by the roentgen rays. As the roentgen ray tube with the slit was moved backwards towards the posterior pole of the eye the ring became smaller and smaller. Finally all that was seen was a small, shining, yellow-green spot. At this moment the roentgen ray beam was considered to be striking the posterior pole of the retina. A figure for the length of the eyeball could then be obtained by measuring in this position the distance between the roentgen ray beam and the beam of light running parallel with it and marking the position of the top of the cornea. RUSHTON stated that, with this method, the error was 0.1 mm. at the most.

The technique described by RUSHTON has now been modified by the

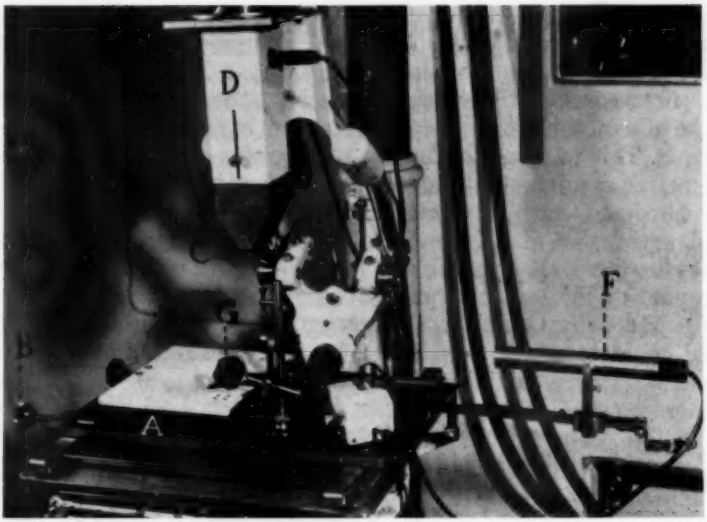

Fig. 1.

writer, in cooperation with S. STENSTRÖM for use in the case of patients with foreign bodies in or close to the eyeball. Instead of moving the roentgen ray beam backwards in relation to the eye until it strikes the posterior pole of the eye, as RUSHTON suggested, we keep the position of the beam unaltered and move the eye forward. This modification has been introduced in order to make it possible to use the method with Lysholm's skull-table in conjunction with the locating apparatus previously described by the writer. The shadow of the cornea is visualized on a film after the eye has been moved until the roentgen ray beam strikes the posterior pole. In patients with a foreign body in the orbit opaque to roentgen rays it is possible, in some instances, to determine directly from the film the position of the foreign body in relation to the plane striking the posterior pole of the eye and appearing on the film as a narrow black streak. The way in which the eye is moved in relation to the slit

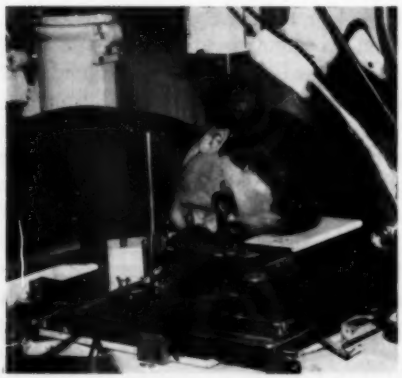

Fig. 2.

is to move the whole of the previously described locating apparatus, on the head support of which the head of the person being examined is fastened, on a plate situated under the head support (A), the latter, in its turn, being attached to a Lysholm's skull-table. The move is effected by means of a screw (B). The roentgen rays pass through a slit-shaped diaphragm (C), with apertures of various sizes which is attached to the roentgen ray tube by means of a telescopic tube (D). The length of the latter can be adjusted so as to allow the slit to be brought as close as possible to the eye which is to be examined. Inside the telescopic tube there is a small electric lamp, placed so that its light, when it passes out through the slit, will reflect the direction of the centre roentgen-ray. It is used for bringing the eye roughly into focus under the slit.

When the length of the eyeball is to be determined, the patient lies prone, as a rule, with his head turned to one side so that the affected eye is nearest to the slit and slightly in front of the other eye. The beam then only has to pass through a relatively thin layer of tissue in order to reach the posterior part of the eyeball.

The position of the examined eye is fixed by means of a tube (F) with a weak red light and two graticules. The head is moved until the patient indicates that the graticules coincide, and it is then fixed by means of the oral support (G). A cassette is inserted in a groove on plate A. This cassette is thus not moved when the position of the locating apparatus is changed. After the eye has been roughly brought into focus under the centre of the slit by means of the screw B, the light in the room is switched off and the patient is allowed to adapt his eyes to the darkness over a period of at least 5 minutes. His eye is then moved in relation to the slit until the visual perception of the roentgen-rays just disappears. In this position a film is exposed, with the opening of the slit at about 0.1 mm. The position of the slit will then appear on the film as a narrow, darkened streak. The aperture of the slit is then increased forwards in relation to the eye and another film is exposed immediately, with the position of the roentgen ray tube, the eye and the film unchanged. In the second exposure, when the slit is so wide that the whole of the eyeball is covered by the beam of rays, the shadow of the cornea will be visualized on the film.

After correcting for enlargement, the length of the eyeball will be ascertained by measuring on the film the distance from the top of the cornea to the centre of the narrow, darkened streak representing the position of the beam of rays when it struck the posterior pole of the eyeball.

SUMMARY

Description of an apparatus for determination of the axial length of the eyeball.

ZUSAMMENFASSUNG

Beschreibung eines Apparates zur Bestimmung der axialen Länge des Augapfels.

RÉSUMÉ

Description d'un appareil pour déterminer la longueur axiale du globe oculaire.

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AUS DER RÖNTGENDIAGNOSTISCHEN ABTEILUNG DES KRANKENHAUSES DER UNIVERSITÄT, LUND, SCHWEDEN (VORSTAND: PROF. H. HELLMER)

ÜBER EINE SPALTENBILDUNG IN DEN BOGENWURZELN DES 2. LENDENWIRBELS[1]

von

Olle Olsson

Seit langem hat man den Spaltenbildungen in den Wirbelbögen grosses Interesse gewidmet. Die bisher bekannten Möglichkeiten zu derartigen Spaltbildungen gehen aus der schematischen Abbildung 1 hervor. Häufig und allgemein bekannt ist der sagittale Spalt im Processus spinosus (durch die ausgezogene Linie 1 gekennzeichnet), der die Spina bifida posterior bildet. Er kann einfach durch eine Störung der normalen Ossifikation erklärt werden. Die Wirbelbögen entwickeln sich aus einer Anlage auf jeder Seite, die normalerweise nach hinten in der Mittellinie zusammenwachsen. Durch eine Hemmung dieses Mechanismus kommt es zum Bestehenbleiben eines Spaltes.

Die Spondylolyse, ein Praerequisitum der Spondylolisthese, ist eine Spaltenbildung in dem Interartikularteil des Bogens (2, Abb. 1), die ein- oder doppelseitig vorkommt. Sie lässt sich schwerer erklären, da jede Bogenhälfte normalerweise nur einen Verknöcherungspunkt hat. Nach der herrschenden Anschauung ist die Spondylolyse angeboren und auf eine abnorme Ossifikation zurückzuführen.

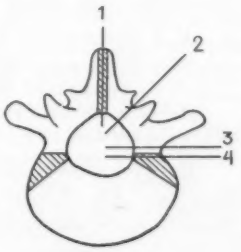

Abb. 1.
Schematische Darstellung der Verschmelzungslinien der verschiedenen Verknöcherungspartien des Wirbels (schraffiert) und mögliche Spaltbildungen (ausgezogene Linien) im Bogen.

Die ausgezogene Linie 3 der Abbildung kennzeichnet eine Spaltbildung der Bogenwurzel, des kurzen Verbindungsgliedes zwischen dem Wirbelkörper und dem die Gelenke tragenden Teil des Bogens. Nur ein Fall mit einer Spaltenbildung in dieser Bogenpartie ist bisher beschrieben worden. Im Jahre 1936 teilt nämlich HAMMERBECK einen Fall mit einem derartigen Spalt im Bogen

[1] Bei der Red. am 3. VI. 1948 eingegangen.

des 4. Lendenwirbels mit, den er bei der Sektion eines Wibelsäulenpräparates eines 50-jährigen fand. Als Ursache nimmt er an »eine an abnormer Stelle angelegte persistierende Epiphyse ....., deren Entstehung entweder auf eine überzählige Knochenkernanlage oder auf eine Knochenkernspaltung zurückzuführen ist».

Der auf dem Schema als Typ 4 eingezeichnete Spalt liegt in der Verknöcherungsgrenze, an der die beiden Bogenhälften mit dem Wirbelkörper verschmelzen. Diese Epiphyse schliesst sich im Alter von 3—6 Jahren. Wenn sie offen bleibt, kann also eine persistierende Spaltenbildung entstehen. MEYER-BURGDORFF und KLOSE-GERLICH haben bei 60 Neugeborenen das Rückgrat anatomisch untersucht und dabei besondere Aufmerksamkeit u. a. dem Bogen und dem Übergang vom Wirbelkörper zum Bogen gewidmet. Hierbei wurden 2 Fälle mit Spaltenbildungen zwischen dem Wirbelkörper und dem Bogen festgestellt. Diese Spalten waren weder durch Knorpel noch durch Bindegewebe ausgefüllt. Die Verff. schliessen daraus, dass Spaltbildungen zwischen dem Wirbelkörper und dem Bogen vorkommen können, heben aber hervor, dass es sich dabei immer um Veränderungen in ausgedehnteren Gebieten des Rückgrats handelte, die schon in das Gebiet der Missbildungen gehören. *Nach Abschluss der Verknöcherung der Wirbelsäule ist eine derartige Spaltenbildung bisher noch nicht nachgewiesen worden.* Dieses ist umso auffallender, als die andere Verschmelzungslinie der Bögen, nämlich die im Processus spinosus, so häufig Sitz einer Spaltbildung wird. Der Verf. hat vor kurzem einen Fall mit einer Veränderung untersucht, die auf das Vorhandensein einer Spaltbildung der genannten Art schliessen lässt.

A. T. Fräulein. 37 Jahre. Orthop. Kl. 443/48.

1941 Erythema nodosum und Pleuritis. Seit 1936 ab und zu Hexenschuss mit seit Ende 1947 beständigen Beschwerden.

Objektiv nichts Pathologisches. Keine neurologischen Symptome. Temperatur normal. Senkungsreaktion 11 mm.

Röntgenuntersuchung der Lendenwirbelsäule: Geringe linkskonvexe Skoliose der Lendenwirbelsäule. Schwache Lumballordose. Höhe der Zwischenwirbelscheiben ohne pathologischen Befund. An einigen Stellen findet man geringe Randwülste an den Wirbelkörpern. Einige kleine Knorpelknötchen finden sich im oberen Teil der Lendenwirbelsäule in den Endplatten der Wirbelkörper.

Der Bogen des 2. Lendenwirbels zeigt auf beiden Seiten einen 1—2 mm breiten Spalt in der Bogenwurzel direkt am Übergang von dieser zum Wirbelkörper. Dieser Spalt, dessen Lokalisation und Aussehen auf beiden Seiten gleich ist, hat einen leicht bogenförmigen Verlauf, und seine Kante ist etwas unregelmässig erhöht. Der Kalkhalt des Bogens ist normal. Keine Zeichen für einen destruktiven Prozess. Keine periostale Knochenneubildung. Keine Weichteilveränderungen.

Die Lendenwirbelsäule zeigt im übrigen keine Abweichungen vom normalen. Keine Spondylolyse, keine Spina bifida, keinen Übergangswirbel.

Der Fall sollte keinen Anlass zu weitläufigen differentialdiagnostischen Spekulationen geben. Die doppelseitigen, gleichförmigen Spaltenbildungen gleichen denen, die man bei der bekannten Spondylolyse des interartikulären Bogenteils beobachten kann. Es liegt am nächsten, die Ursache in einer Entwicklungsstörung zu suchen. Bevor die Art dieser besprochen wird, soll die Embryologie des Wirbels in Erinnerung gerufen werden.

Abb. 2. Seitenaufnahme des L_{II}. Im vorderen Teil der Basis der Bögen bilaterale Spaltbildung.

Die Embryologie des Wirbels: Nach MALL zeigt sich die erste Verknöcherung im allgemeinen am Ende des zweiten Foetalmonats, und zwar zuerst in den Bögen. Hierbei bildet sich in jeder Bogenhälfte ein Ossifikationszentrum. Die Verknöcherungen der Wirbelkörper beginnen etwas später und treten auf in Form »eines unpaaren, zentralen, perichordalen Kalkknorpelkernes» (SCHINZ & TÖNDURY). Dieser wird durch hereinwachsende Blutgefässe resorbiert und bildet den primären Markraum, um den sich die ersten Knochenbälkchen herum entwickeln. Die drei Verknöcherungszentren des Wirbels nehmen darauf an Grösse zu, sind aber während des ganzen Foetallebens durch persistierende Knorpelpartien voneinander getrennt (BROMAN). Am Processus spinosus geschieht die Verschmelzung für gewöhnlich während des ersten Lebensjahres. Erst im dritten bis sechsten Jahre verschmelzen die Bögen mit den Wirbelkörpern. Nach vollendeter Verschmelzung bildet die Basis der Bögen, wie aus der Abbildung 1 hervorgeht, den lateralen hinteren Teil des Wirbelkörpers.

Der Befund des vorliegenden Falles deutet darauf hin, dass die Spaltbildung auf das Verknöcherungsgebiet, in dem die beiden Bogenteile mit dem Wirbelkörper verschmelzen, zu beziehen ist. Wie erwähnt, entwickelt sich jedoch ein nicht geringer Teil der hinteren lateralen Partien der

Abb. 3. Schiefaufnahme des L_{II}, die die Lage der Spalten dicht an der hinteren Wirbelkörperkante zeigt.

Wirbelkörper aus den Bögen. Die Epiphysenlinie liegt deshalb innerhalb des definitiven Wirbelkörpers. Ihr Verlauf bildet im Horizontalschnitt einen Winkel von c:a 45° mit der Frontalebene. Eine Spaltenbildung in dieser Epiphysenlinie müsste also innerhalb des Wirbelkörpers liegen und schräger verlaufen.

Der Verf. hat einige Rückenpräparate von Kindern im Alter von 0—6 Jahren radiographiert. In diesen wechselte der Einfallswinkel der besprochenen Epiphysenlinie zur Frontalebene in verschiedenen Teilen des Rückgrates ziemlich stark. Während der Verlauf der Epiphysenlinie z. B. am S_I fast sagittal sein kann, nimmt der Winkel innerhalb der Lendenwirbelsäule ab, und am L_{II} und L_{III} liegt die Epiphysenlinie nahe die Frontalebene (Abb. 4). Hierzu kommt, dass die Epiphysenlinie am Übergang von der Brust zur Lendenwirbelsäule relativ mehr nach hinten rückt, was durch die Form des Wirbelkörpers bedingt wird. Die Hinterfläche der Wirbelkörper hat nämlich in dieser Region eine deutlich konkave Form. Auf der Röntgenaufnahme wird deshalb die Epiphysenlinie in die hintere Kante des Wirbelkörpers projiziert (Abb. 4). Auf dem Radiogram des Rückgrats aus den ersten Lebensjahren zeigt sich darum die Epiphysenlinie am Übergang von der Brust zur Lendenwirbelsäule in Form einer deutlichen Aufhellungslinie, während ihre Lage und ihr Verlauf im übrigen Rückgrat weniger deutlich hervortritt.

Im Hinblick auf das oben Gesagte, dürfte die geschilderte Spaltenbildung an der Grenze zwischen der Bogenwurzel und dem Wirbelkörper des L_{II} am einfachsten als eine Hemmung der normalen epiphysären Verknöcherung in den normalen Ossifikationszonen erklärt werden zu können. *Der Fall ist deshalb nicht nur der erste, bei dem die Spaltbildung in der Bogenwurzel in vivo festgestellt wurde, sondern auch wahrscheinlich der erste mit einer isolierten Spaltenbildung in derjenigen Verknöcherungszone, in der die knöcherne Überbrückung zwischen dem Wirbelkörper und Bogen normalerweise stattfindet.*

Zum Schluss soll auf Folgendes aufmerksam gemacht werden. Der Verlauf der Verknöcherungslinien kann die Annahme hervorrufen, dass

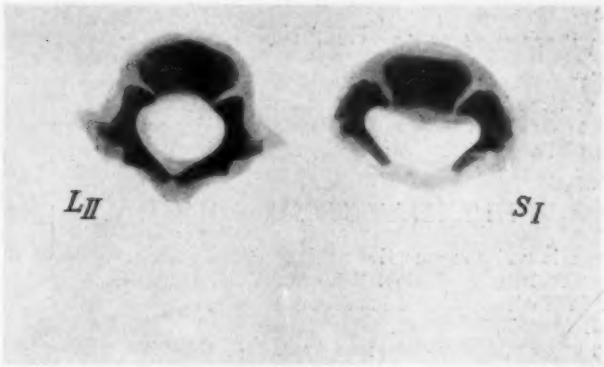

Abb. 4. Radiogram eines Wirbelpräparates eines Neugeborenen. L_{II} und S_I. Beachte den Verlauf der Epiphysenlinien. Am S_I verlaufen sie fast sagittal, während ihre Richtung am L_{II} wesentlich stärker frontal ist. Beachte ausserdem die Form der hinteren Wirbelkörperfläche, die am L_{II} stark konkav ist.

in dieser Region eventuell persistierende Epiphysenlinien auf gewöhnlichen Übersichtsbildern des Rückgrats in Frontal- oder Seitenprojektion nicht sichtbar gemacht werden. Hierauf wäre zurückzuführen, dass Spaltbildungen hier nicht eher entdeckt worden sind. Eine derartige Erklärung kann jedoch kaum richtig sein, wenn man berücksichtigt, dass in dem Institut von Schmorl in dem grossen Material anatomisch untersuchter Wirbelsäulen niemals bei Erwachsenen Spaltbildungen an dieser Stelle gefunden wurden (JUNGHANNS). Eine derartige Spaltbildung ist offenbar als eine sehr grosse Seltenheit anzusehen.

ZUSAMMENFASSUNG

Beschreibung eines Falles mit einer Spaltbildung in den Bogenwurzeln des zweiten Lendenwirbels. Die Veränderung, die früher nicht in der Literatur beschrieben worden ist, dürfte als eine Störung in der Verknöcherungszone, in der der Bogen normalerweise mit dem Wirbelkörper verschmilzt, anzusehen zu sein.

SUMMARY

Description of a case of split formation in the arch root of the second lumbar vertebra. The change, which has not earlier been described in the literature, may be regarded as a disturbance in the ossification area, where the arch is normally connected with the vertebral body.

RÉSUMÉ

Description d'un cas où existait une solution de continuité à la racine des arcs de la deuxième vertèbre lombaire. Cette altération, non décrite jusqu'ici dans la littérature, doit sans doute être considérée comme le résultat d'un trouble au niveau de la zone d'ossification où l'arc se fusionne normalement avec le corps vertébral.

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FROM THE ROENTGENDIAGNOSTIC DEPARTMENT OF THE CAROLINE HOSPITAL, STOCKHOLM, SWEDEN (CHIEF: PROFESSOR ÅKE ÅKERLUND)

ON A PECULIAR LATE REACTION IN RADIOLOGICALLY TREATED CASES OF CANCER OF THE HYPOPHARYNX[1]

(Preliminary Observations)

by

Sölve Welin

A change in the roentgen picture, to which one usually pays no great attention, is that which appears subsequent to radiotherapy. Yet, the reaction following irradiation is a factor which radiologically may be of the greatest importance with regard to differential diagnosis, therapy and perhaps above all, prognosis. Let us consider, for example, the so-called reactive phase following irradiation of bone tumors. The reduction of the calcium content found in these cases may very well be the result of the treatment and is by no means necessarily a sign of any progression of the tumor. This change may even persist for many years. These are conditions which, at least previously, were not taken into due consideration and which were sometimes misinterpreted. This is illustrated by figures 1 and 2. They are obtained from a case of cancer of the breast which in 1946 had skin metastases in the sternal region. These were treated with teleradium. Two years after this treatment there still remains a structural change which shows great similarity to an osteoclastic metastasis but which is merely a result of the irradiation.

Also in many other fields than that of bone tumors one has to consider diagnostically the possibility of reactive phenomena. At the periodical follow-up examinations of the cases of cancer of the hypopharynx treated by radiotherapy, the author has thus — in addition to the usual primary reaction with the subsequent atrophy of the mucous membrane — also been able in some cases to establish a *later* change which must be considered in direct connection with the radiation treatment received.

Of the 327 patients with histologically verified cancer of the hypopharynx, treated at the Caroline Hospital since its inauguration eight

[1] Submitted for publication, July 2, 1948.

Fig. 1. Roentgenogram of sternum preceding radiation.

Fig. 2. Roentgenogram of sternum following radiation.

years ago, 195 cases have been followed up with repeated roentgen examinations. Five out of this total of 195 cases did exhibit a picture which was strongly suggestive of that of a local recurrence. In fact, no recurrence was really present.

On examination we found in 4 cases that the prevertebral soft-tissue shadow, after an initial regression, had again increased in width and that in one case a filling defect of the pyriform sinus had appeared. There was also in 3 of the cases a reappearance of irregularity of the mucous membrane.

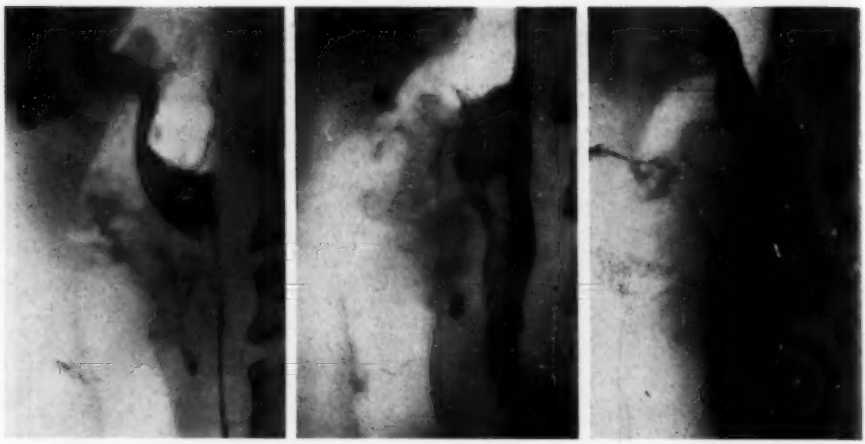
Fig. 3. Fig. 4. Fig. 5.

Fig. 3. Lateral view of the hypopharynx, showing a tumor with among others increased width of the prevertebral soft tissues.

Fig. 4. Same case, 3 months following roentgen treatment, showing considerable regression.

Fig. 5. Same case, 9 months after treatment, showing signs interpreted as local recurrence.

Fig. 3—12 demonstrate this. Fig. 3—6 are roentgenograms of a 36-year-old female patient, 15893/44, who was admitted to the Radiumhemmet for progressive dysphagia lasting 2 months. On examination we found a tumor the size of a walnut in the left ary-epiglottic region and the laryngeal vestibule and the roentgen findings revealed a pathologically increased width of the prevertebral soft-tissue shadow, enlargement of the ary-epiglottic region, deformity of the introitus laryngis, and a ragged outline of the mucous membrane down to the level of the 7th cervical vertebra (fig. 3). We were dealing therefore with a very extensive neoplasm. On fig. 4, showing the condition 3 months after roentgen treatment, it is shown that a considerable regression has taken place. The prevertebral soft-tissue shadow is of normal width and there is now merely a trace of the indentation of the anterior hypopharyngeal wall. This now has a smooth outline of the mucous membrane and the picture suggests an atrophic mucosa. *Six months later, the prevertebral soft-tissue shadow has again increased in width and the outline of the mucous membrane has again become ragged.* (Fig. 5.) These changes were first interpreted as signs of a local recurrence. At direct hypopharyngoscopy, however only a slight edema in the ary-epiglottic region was observed



Pig. 6. Fig. 7. Fig. 8.

Fig. 6. Same case, 15 months after treatment, showing disappearance of the previous changes and disproving the earlier diagnosis of recurrence. No treatment was given after the original treatment.

Fig. 7. Lateral radiograph of hypopharynx, previous to radiation, showing a large tumor.

Fig. 8. Same case, 2 months after treatment, showing considerable improvement in the picture.

and distal to this a smooth mucosa with no bleeding or ulceration. The suspicion of a recurrence could thus not be verified by endoscopy which showed the cancer well healed. At a repeated roentgenological follow-up examination 6 months later (fig. 6) regression was established: the prevertebral soft-tissue shadow had again decreased to normal width, and the outline of the mucous membrane was again smooth.

In another female patient (5407/45) who did not come to the Radiumhemmet until after 18 months progressive dysphagia the similarities to a recurrence were still more striking. Fig. 7 shows the appearance of the widespread papillomatous tumor prior to irradiation. Two months after treatment — fig. 8 — a considerable regression was observed: the prevertebral soft-tissue shadow had decreased in breadth and the mucous membrane had become considerably smoother. On fig. 9, which is from a follow-up examination 6 months after the roentgen treatment the *prevertebral soft-tissue shadow has again increased in breadth and the mucous membrane has become papillomatous with a marked upper as well as lower ridge-like interruption of the contour*. The changes were roentgenologically interpreted as arising from a local recurrence. As on laryngo-

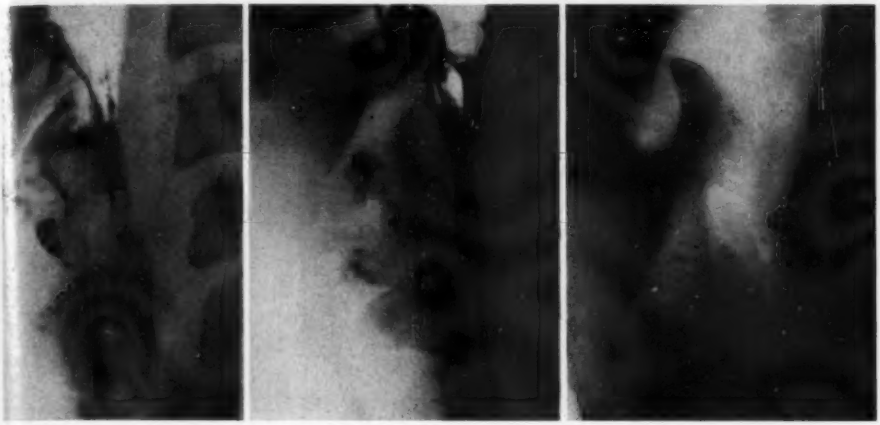


Fig. 9. Fig. 10. Fig. 11.

Fig. 9. Same case, 6 months after treatment, showing changes interpreted as local recurrence.

Fig. 10. Same case, 12 months after treatment, showing normal appearance of the structures and disproving the earlier diagnosis of recurrence. No treatment was given after the original treatment.

Fig. 11. Radiograph of hypopharynx, showing normal appearance, 2 months following radiation treatment.

scopy only edema was observed and the patient was virtually free from discomfort, and considering that the tumor had already received a dose of between 5,200 and 5,800 r/28 days, it was decided that she was to return in 3 months for re-examination prior to any further possible treatment. At the roentgen examination then undertaken it was revealed that the changes had regressed entirely and after another 3 months the picture remained unchanged, and, as seen in fig. 10, was typical of an irradiated hypopharynx with an atrophic outline of the mucosa, displaced lumen and rigid contours.

In a 67-year-old male patient (19071/45) the changes were, in contrast to the other cases localized further up and mainly situated round the epiglottis. This patient had complained of difficulty in swallowing, which the remainder of my five patients had not done. On fig. 11, which shows the status 2 months after irradiation, the epiglottis, the ary-epiglottic region and the prevertebral soft-tissue shadow exhibit normal configuration and size. At the next follow-up examination — 2 months later (fig. 12) — *the epiglottic has increased in size, the ary-epiglottic region is swollen and the vertebral soft-tissue shadow has increased in width.* Direct

Fig. 12. Fig. 13. Fig. 14.

Fig. 12. Same case, 4 months following treatment, showing thickened epiglottis and increased in prevertebral soft-tissues.

Fig. 13. Lateral radiograph of the post-cricoid region. 4 months following radiation, showing changes suggestive of recurrence.

Fig. 14. Frontal radiograph of the same case, taken at the same time, showing filling-defect in the right pyriform sinus. As this had not been noted previously a diagnosis of recurrence was made. This was later verified histologically.

hypopharyngoscopy showed no more than thickened epiglottis with intact mucosa and a moderate swelling in the ary-epiglottic region, nor did biopsy show any signs of cancer.

In the two remaining cases (914/33 and 3463/41) the changes were similar and in *all the cases the changes on the roentgenogram have been such that it was not possible to rule out a local recurrence.* But the further course proved that there was no question of a recurrence of cancer. The changes disappeared without the patients having received any further treatment and the clinical examinations with regard to the presence of a recurrence remained negative. Indirect as well as direct laryngoscopy and direct hypopharyngoscopy have shown edema only, and also, in the case in which biopsy was performed, there was no sign of cancer.

The explanation of these changes should probably be sought in a *late reaction* after irradiation *or* they should be considered as an *expression of the reaction of the irradiated tissue to some extrinsic insult, i. e. an infection.*

As yet it appears that at least in some cases it is impossible to make a certain radiological differential diagnosis between the changes observed

and a true recurrence of cancer. In some cases, however, this ought to be possible, *e. g.* when the changes extend upwards to the laryngeal vestibule and sinus piriformis. If in some cases a difference between the right and the left side be found, this would favour a local recurrence as illustrated by the following case.

A 49-year-old female patient (17380/45) was treated at the Radiumhemmet for a histologically verified cancer of the hypopharynx. Tumor dose 6355 r/ 38 days. After treatment the patient felt well, was able to eat all kinds of foods, and gained in weight. At a follow-up examination 4 months after the radiation treatment it was observed that the *prevertebral soft-tissue shadow had again increased in breadth and that the outline of the mucous membrane had become irregular and ragged in an area of 2½ cm in length in the post-cricoid region.* (Fig. 13.) Although clinically the patient was in a comparatively good condition the diagnosis of recurrence was made, as there existed on the frontal picture (fig. 14) a filling defect which at the previous examinations had not been there. At direct hypopharyngoscopy slightly edematous ary-epiglottic regions were found. The necrotic parts were cleaned out with biopsy forceps. There was moderate bleeding. No definite tumor remnants were observed and the impression gained was that no tumor remained. Necroses and small pieces of tissue were sent for microscopic examination. This latter revealed cancerous tissue and the roentgen diagnosis was accordingly verified.

The time between irradiation and the first appearance of the changes described has varied considerably. In one case they appeared as early as 3 months after the irradiation: the longest interval was 11 months and thus no guidance to a correct diagnosis is afforded.

There has been no difference in the treatment of these cases and the remainder of the patients — they have all been treated according to the standard method used at the Radiumhemmet with roentgen irradiation from four fields. In approximately 30 days all had received a tumor dose of between 5,600 and 6,000 r.

As we do not know how commonly such a late reaction may arise and as we have not been able to establish whether there is any particular group of patients in whom it appears, a more systematic examination has been initiated.

It is, however, important to bear in mind the possibility of late reactions in the evaluation of the prognosis and to suggest in cases of a suspected recurrence a direct hypopharyngoscopy with biopsy.

SUMMARY

At periodical follow-up examinations of radiologically treated cases of cancer of the hypopharynx the author has, apart from the usual primary reaction, been able to establish delayed changes in five cases, viz: increased width of the prevertebral soft-

tissue shadow, and a renewed occurrence of irregularity of the mucous membrane. These changes, radiologically indistinguishable from a local recurrence, disappeared without any further treatment. All clinical examinations with regard to the presence of a recurrence also remained negative. These changes are presumably caused by a late reaction after irradiation or they could be considered as an expression of the reaction of the irradiated tissue to some extrinsic insult, *i. e.* an infection.

ZUSAMMENFASSUNG

Bei den periodisch wiederkehrenden, röntgenologischen Kontrolluntersuchungen von strahlenbehandelten Fällen von Hypopharynxkrebs hat Verf., ausser der gewöhnlichen initialen Reaktion, bei fünf Fällen auch noch eine später auftretende Veränderung in Gestalt einer Breitenzunahme des prävertebralen Weichteilschattens und einer erneut auftretenden Unregelmässigkeit der Schleimhaut feststellen können. Diese Veränderungen, die sich röntgenologisch nicht von einem lokalen Rezidiv unterscheiden, sind ohne weitere Behandlung zurückgegangen. Auch bei den klinischen Untersuchungen haben sich keine Anzeichen eines lokalen Rezidivs ergeben.

Die Erklärung dieser Veränderungen ist deshalb wohl wahrscheinlich in einer spät auftretenden Reaktion der strahlenbehandelten Gewebe nach einem äusseren Insult, z. B. einer Infektion, zu suchen.

RÉSUMÉ

Lors des examens radiologiques de contrôle, renouvelés périodiquement, des cas de cancer de l'hypopharynx traités par les Rayons, l'auteur a pu, dans cinq cas, en plus de la réaction initiale habituelle, constater des altérations survenant plus tard sous la forme d'une augmentation en largeur de l'ombre des parties molles prévertébrales et d'une réapparation de l'irrégularité de la muqueuse. Ces modifications, qui ne peuvent, radiologiquement, être distinguées d'une récidive locale, ont rétrocédé sans autre traitement. Les examens cliniques n'ont pas non plus montré de signes de récidive locale.

L'explication de ces altérations peut donc vraisemblablement être cherchée dans une réaction, survenant tardivement, du tissu irradié, cela à la suite de quelque insulte extrinsèque, comme par exemple une infection.

FROM THE ROENTGEN DEPARTMENT, LASARETTET, NORRKÖPING (HEAD: G. RENCK)
AND CENTRALLABORATORIET, A.-B. ASTRA, SÖDERTÄLJE, SWEDEN

A VISCOUS, WATER-SOLUBLE CONTRAST PREPARATION[1]

Preliminary Report

by

O. Morales and *H. Heiwinkel*

For many years iodized oils have been extensively used as radiopaque contrast media. They give good opacity, are highly viscous and, therefore, do not flow quickly out of the examined organ. Finally, they are non-irritant, as long as they are of suitable quality. The disadvantages of iodized oils are, however, considerable and they are therefore avoided more and more. Their greatest disadvantage is that they are not soluble in water. They do not, therefore, mix with the body liquids, thereby causing distortion of the roentgen picture: this is particularly marked when introducing these contrast media into the liquid conveying channels (*e. g.* spinal canal, urethra). Another disadvantage is that they are not absorbed from the organ but must be removed by other means. In those cases where this is impossible, for instance in the bronchial tree or the subarachnoid space, one can find solid lumps of contrast medium several years after a roentgen examination. Cases have also been described (1), in which the decomposition of these contrast deposits has caused irritation, for example in the lungs, and produced granulations. Another drawback of iodized oils is that on entering the blood vessels they can cause embolies which result in serious complications (2). If they are stored for any length of time, especially when effected by air and light, they decompose and form toxic products. On account of these disadvantages, contrast media which are soluble in water are preferred, in spite of the fact that then one forfeits the advantage of higher viscosity.

It would be of value to have access to a contrast medium both suitably viscous, and soluble in water, and which can be absorbed. It must, of course, be non-irritant. It must be sufficiently stable to endure sterilization and storing.

[1] Submitted for publication, May 20, 1948.

In producing roentgen contrast media, mainly for use in gynecology, various types of viscous preparations, soluble in water, have been described. TITUS and coworkers (3) added 20 per cent acacia to a 40 per cent solution of abrodil. RUBIN (4) suggested a similar preparation, called Visco-Rayopake, consisting of a 67 per cent solution of the diethanolamine salt of 2, 4-di-oxo-3-iodo-6-methyl-tetrahydropyridine-1-acetic acid and 3 per cent polyvinyl alcohol. This preparation has been described in the American literature but, as far as we know, it is not yet on the market. BRODNY and ROBINS (5) have used it in urethrocystography, and NORMENT (6), MONTGOMERY and LANG (7) in hysterosalpingography.

For some years we have experimented with different media in order to obtain a preparation of high viscosity and soluble in water. As contrast substance we have used umbradil (diethanolamine salt of 3, 5-diiodo-4-pyridone-N-acetic acid). Natural products which increase viscosity such as pectin, acacia, dextrin and others have proved unsuitable on account of the very high concentration necessary to produce the viscosity desired and their incompatibility with the contrast substance. Alginate certainly gave good viscosity in low concentrations, as did polyvinyl alcohol, but produced too high a degree of irritation to be suitable. The preparation, which we have found to fulfill our demands is sodium carboxymethylcellulose (called CMC). It is a cellulose ether made by the reaction of monochloracetic acid with alkali cellulose. Its sodium salt is easily soluble in water and, at concentrations as low as 1—3 per cent, forms highly viscous solutions which are completely clear and colourless. They do not gelatinize, even on storing, and are completely non-irritant.

BROWN and HOUGHTON (8) and WERLE (9) have administered CMC to dogs and rats per os. Post mortem examinations of the vital organs showed these to be normal in every way.

In trying to find a blood plasma substitute, HUEPER (10) injected intravenously a 0.25 per cent solution of CMC daily in dogs. The daily dose was 40 cc. during the first month, 75 cc. during the second month and, finally, 150 cc. during the third month. Thus, each dog received a total amount of nearly 20 gm. of CMC. CMC was found in the reticuloendothelium of the liver and the spleen and the endothelial cells of the renal glomeruli, as were other highly polymeric substances such as pectin, acacia and methylcellulose, although CMC was present to a considerably lower degree than these. The presence of scattered blue patches in preparations coloured with hematoxylin-eosin in the lumina of the kidney tubuli gave reason to conclude that CMC was secreted through the kidneys. In contrast to methylcellulose, CMC is not stored in the cells of the liver, but only in the Kupffer's stellate cells.

With the kind help of the late Dr. K. A. HERMANSSON, veterinary sur-

geon at the slaughter-house n Norrköping, we have been ble to test the contrast me- lium by intra-articular in- ections in calves. As the oint synovia is highly sensi- ive to irritation of all types, eacting with dilated vessels nd hydrops, and is easily ccessible, it was chosen for he tests. It was revealed, among other things, that polyvinyl alcohol in a water solution caused a moderate hydrops and distinctly dila- ted vessels. On the other hand, no irritation could be observed after injections of CMC-solutions. We also in. jected umbradil, containing CMC, and to establish the fact that the contrast medi- um was in an intra-articular position, a roentgen exami- nation of the knee was car- ried out (Fig. 1). No irrita- tion could be observed. Rab- bits were also experimented upon, 10 cc. contrast medi- um, containing CMC being administered in intraperito- neal and intrapleural injec- tions and, in smaller a- mounts, subpericardial in- jections. Similarly, 1 cc. was injected subcutaneously and 10 cc. intravenously. An examination of the animals the following day, and again 14 days later, revealed no macroscopic remains of the contrast medium which, 24 hours after injection, could not be found by means of roentgen (Fig. 2). After intravenous injections the contrast medium was seen to be secreted by the kidneys, and a microscopical examination revealed no changes which could be attributed to the preparation. Intracutaneous, sub-

Fig. 1. Contrast preparation in knee-joint of calf.

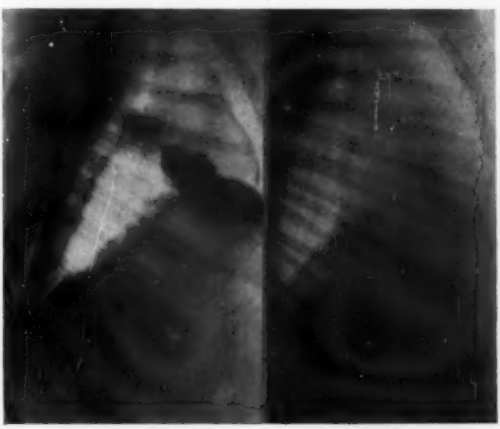


Fig. 2 a. Contrast preparation in pleura and pericard of rabbit.

Fig. 2 b. The day after injection. No contrast visible.

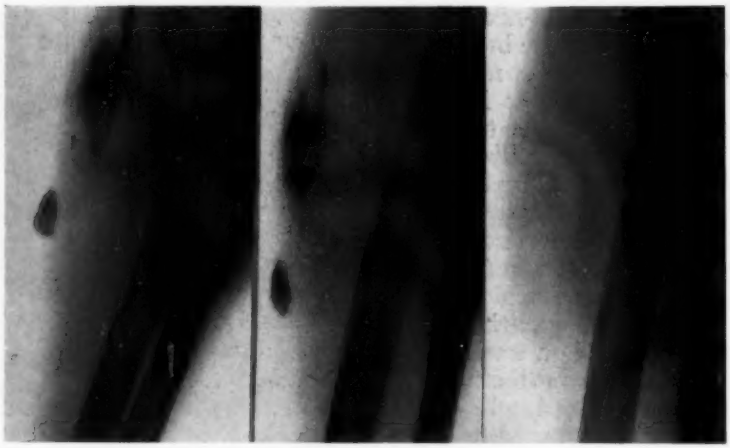


Fig. 3 a. Fig. 3 b. Fig. 3 c.

cutaneous and intramuscular injections of a few cc. were also carried out in humans (Fig. 3).

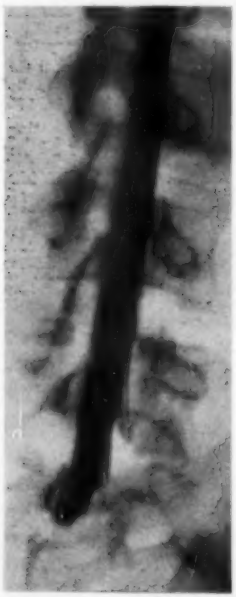


Fig. 4.

The contrast medium used was made up as follows: 35 per cent umbradil, giving a contrast which is, perhaps, too faint for bronchography and too opaque for examination of larger hollow organs; 2.5 per cent CMC which gave a viscosity of about 500 cps., comparable to the viscosity of glycerol at a temperature of 25° C (the contrast solution was, therefore, of about the same viscosity as lipiodol); to avoid pain during injection 0.25 per cent xylocain (ω-diethylamino- 2, 6-dimethylacetanilide) was added as anesthetic. This mixture can, of course, be modified to suit the purpose of the examiner with regard to both opacity and viscosity.

Fig. 3 a. Contrast intra- and subcutaneously and intramuscularly in forearm.

Fig. 3 b. Two hours after injection. No contrast at the place of the intracutaneous injection.

Fig. 3 c. Four hours after injection. No visible contrast left.

Fig. 4. Myelography in corpse. Note the root sheaths.

Fig. 5 a.

Fig. 5 b.

Fig. 5 c.

Fig. 5 a. Urethrocystography in vivo. Normal picture.
Fig. 5 b. Urethrocystography in vivo. Special picture of the prostatic urethra.
Fig. 5 c. Urethrocystography in vivo. Cancer of the bladder. Note contrast filled, delated ducts of the prostate.

The preparation had, however, previosuly been tested on corpses to discover whether it could fill the fine channels in spite of its high viscosity. To this end, a myelogram (Fig. 4) and a knee joint arthrogram in corpses were carried out. The contrast could be followed into the root-sheaths and the menisci appeared with desirable destinctness.

In urethrocystography in vivo, under fluoroscopic control, a contrast

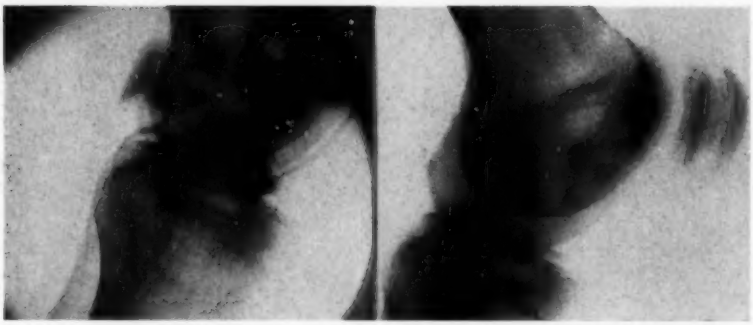


Fig. 6 a. Arthrography of knee-joint in vivo. Normal picture.

Fig. 6 b. Two hours after the injection. No contrast left.

of considerably higher viscosity was used (4 per cent of CMC with a viscosity of 5,000 cps., its consistency comparable to that of syrup). The patients felt no discomfort at all in the form of either pain or smarting. The urethra with all anatomical details appeared clearly. The fine channels of the prostate often appeared distinctly, showing that the contrast medium could enter these channels in spite of its high viscosity. On account of the high density of the contrast, however, it was not possible to obtain more than »silhouette pictures» of the bladder, but by decreasing the umbradil content to 15—20 per cent this organ also becomes accessible for examination with the same preparation. As CMC is easily soluble in water, no drop formations occurred in the bladder as in the cases examined with iodized oils: the bladder was filled homogeneously with the contrast preparation (Fig. 5).

A number of organs have been examined with the more fluid preparation (2.5 per cent CMC with a viscosity of 500 cps). Thus, some hysterosalpingograms have been obtained: the pictures of the uterus cavity and the tubes are in sharpness and opacity similar to those obtained with iodized oil; whereas, when the contrast medium has reached the true pelvis, the organs there appear as in normal pelvioradiography with non-viscous water solutions of contrast substances. After 3 hours only an inconsiderable amount of contrast medium in fossa Douglasi, and a distinct filling of the bladder, can be seen, and after 18 hours there are no traces of contrast, nor is there any sign of any increase of liquid in the true pelvis (Fig. 7).

The preparation has also been used in mammograms and has given clear pictures of the glandular system. The day after examination the patient, on being asked, said that no liquid had run out of the breast; nor could any liquid be extracted by manual pressure (Fig. 8).

Fig. 7 a.

Fig. 7 b.

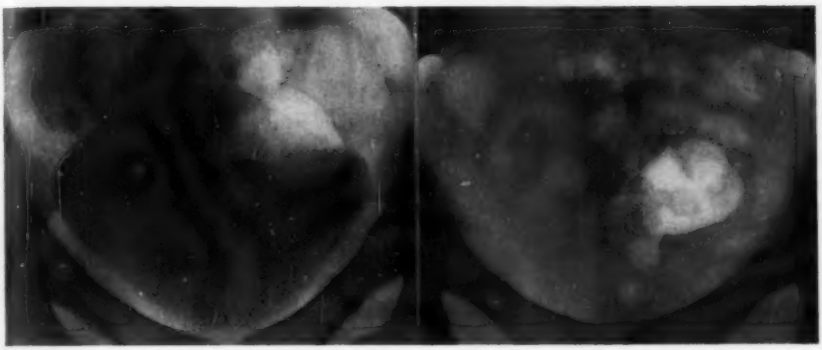


Fig. 7 c.

Fig. 7 d.

Fig. 7 a. Hystero-salpingogram, frontal picture. Note the left oviduct with sacculation.

Fig. 7 b. Contrast in the fossa Douglasi from the right tube (pelvigram).

Fig. 7 c. Two hours later. Contrast in the bladder and the true pelvis. Note the thickness of the bladderwall.

Fig. 7 d. The following day. No visible contrast left.

Fig. 8 a. Mammography. Normal picture.

Fig. 8 b. The following day. No contrast visible.

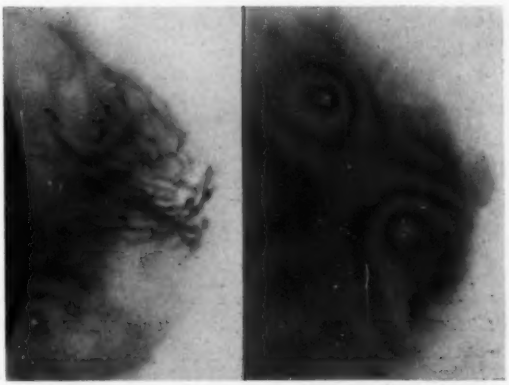


Fig. 8 a.

Fig. 8 b.

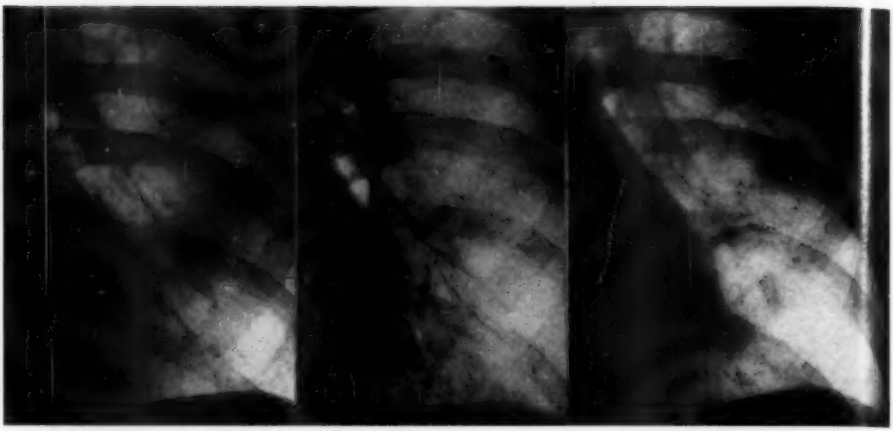


Fig. 9 a. Fig. 9 b. Fig. 9 c.

Fig. 9 a. The lower part of the left lung. Bronchiectasis?
Fig. 9 b. Bronchography shows cylindric ectasis.
Fig. 9 c. Three hours later. No visible contrast left. No new infiltrations. The patient did not cough.

In none of these examinations have the patients felt any discomfort in the form of tension, pain, or in any other way from the contrast preparation, either during or after examination.

Fig. 10. Mediastinal tumour. Bronchography normal.

The main purpose of the contrast medium was, however, to obtain a new preparation for use in bronchography. As there was but little material at the Norrköping hospital the years during which these examinations were carried out, only a few could be performed. Dr. TH. LARSÉN, of the Örebro hospital's Roentgen Department, co-operated kindly and carried out this examination in a number of cases and placed his pictures at our disposal. The upper air passages were first anesthetized, the catheter introduced into the bronchial area affected and the contrast medium injected. The cough reflexes which, when using iodized oils render the examination difficult, hardly occurred at all and a distinct picture of

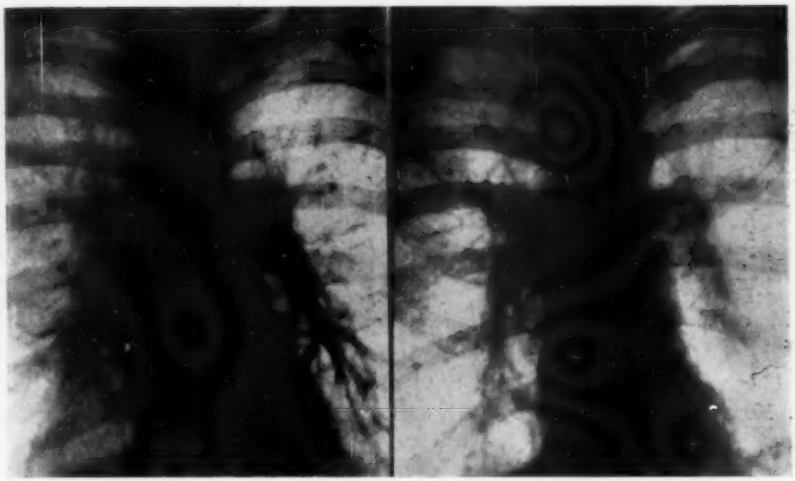


Fig. 11 a. Asthma bronchiale. Normal bronchography.

Fig. 11 b. Three hours later. No visible contrast left.

the bronchial tree could be obtained (Figs. 9—12). A roentgen examination of the lungs a few hours later revealed no certain remains of the preparation in the form of opacity, atelectasis or other infiltrations.

As illustrated above, CMC does not appear to cause irritation of any kind. The rate of absorption is difficult to establish as, at present, there is no known chemical method of determining CMC in the body liquids, The results of current experiments on the absorption will be published later, when we will be able to advise with greater certainty as to the indications in which we consider this roentgen contrast medium could with advantage replace iodized oils.

Fig. 12. Pulmonary tuberculosis with cavern near the right apex.

SUMMARY

The authors describe a contrast preparation, soluble in water, highly viscous and non-irritant, designed to replace iodized oils. It consists of 35 per cent umbradil, 2.5 per cent carboxymethylcellulose (CMC) and 0.25 per cent xylocain. The proportions of the constituents can be modified to suit the purpose of the examiner.

ZUSAMMENFASSUNG

Verff. beschreiben ein wasserlösliches Kontrastmittel von hoher Viskosität und Reizlosigkeit, das die jodierten Öle ersetzen soll. Es besteht aus 35 Prozent Umbradil, 2.5 Prozent Karboxymethylzellulose (CMC) und 0.25 Prozent Xylokain. Die Proportionen der Bestandteile können verändert werden, um den Zwecken des Untersuchers zu passen.

RÉSUMÉ

Les auteurs décrivent un produit de contraste soluble dans l'eau, de viscosité élevée et non irritant, destiné à remplacer les huiles iodées. Il contient 35 % d'Umbradil, 2.5 % de carboxymethylcellulose (CMC) et 0.25 % de xylocaïne. Les proportions des parties qui le constituent peuvent être modifiées selon le but poursuivi lors des examens.

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